Proposal to the Fund Council

Submitted by:

Consortium Board of Trustees

For:

Financial Support to the CGIAR Center Genebanks in 2011

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PART A SUMMARY OF THE REQUEST TO THE FUND COUNCIL

Purpose

This is a proposal to seek financing from the CGIAR Fund for the CGIAR centers' cost of maintaining and distributing CGIAR crop genetic resources, and to cover one-third of the one-time costs of optimizing the existing collections and introducing additional accessions from the regeneration project. These activities' costs were identified and calculated in the 2010 genebank costing study which was commissioned jointly by the Consortium Office and the Global Crop Diversity Trust, in collaboration with the ten CGIAR centers that house crop germplasm. This proposal is to finance the 2011 costs for these activities at the CGIAR centers.

Justification

This proposal is necessary because there are limited sources of financial support for the very basic functions of centers genebanks. This is somewhat of a paradox, because the genebanks are in some respects the "jewels in the crown" of the CGIAR, and the task of maintaining and making these resources available is absolutely a core activity, without which the centers could not fulfill their international responsibilities. But it is true that the nature of these activities does not lend itself to project funding. In the past, therefore, these costs at all centers have been almost entirely financed by unrestricted funding support. In the reformed CGIAR system, that traditional financing category is largely disappearing and within several years may disappear altogether, as the research and support activities will be defined almost entirely within the structures of the CGIAR Research Programs (CRP). As the fundamental genebank activity should not be defined as an overhead, there are very few options for these activities to be considered a research function suitable for a CRP budget. For this reason, the Consortium Board, the centers, and the Global Crop Diversity Trust strongly believe that the CGIAR Fund must finance these activities in the same way that it will finance the CRPs – with allocations that are predictable and allocated annually in response to financing plan requests, i.e. the financial update of long-term budgets approved by the Fund. The proposal is that this financing should be allocated from window 1 of the Fund.

Requirement

The total cost of these core genebank functions in 2011 is $21 million. There are two proposed sources of financing. The first is the GCDT, which has allocated grants in perpetuity for the CGIAR centers; the guaranteed support for the CGIAR in 2011 is $2.1 million. The second source – the focus of this request – is from the CGIAR Fund. The requirement from the Fund in 2011 is $18.9 million. This is composed of the cost of the basic germplasm maintenance and distribution function ($13.1 million) and one-third ($5.8 million) of the total one-time costs for optimizing the collections and introducing additional germplasm from the regeneration project.

The requirements are summarized in tables 1 and 2 below. (Details of the center distribution and activity, and the nature of the one-time costs are provided in annexes 1 and 2.). Table 1 is a summary of genebank requirements overall for 2011 and financing source, and table 2 shows the categories of cost by center.

Table 1: Summary of CGIAR genebank requirements for 2011

	Total Requirement		Allocation Sources	
Center	**US$**	**% of total**	**GCDT**	**CGIAR Fund**
AfricaRice	342,515	2%	0	342,515
Bioversity	970,932	6%	159,181	811,751
CIAT	2,394,585	16%	286,526	2,108,059
CIMMYT	1,165,430	8%	309,181	856,249
CIP	3,231,248	21%	200,000	3,031,248
ICARDA	1,299,908	9%	318,362	981,546
ICRISAT	2,464,419	16%	315,302	2,149,117
IITA	1,130,621	7%	212,242	918,379
ILRI	840,763	6%	84,897	755,866
IRRI	1,393,625	9%	270,608	1,123,017
sub-total	**15,234,045**	**100%**	**2,156,299**	**13,077,746**
Optimizing collections	3,800,352		0	3,800,352
Regeneration project intro	1,994,564		0	1,994,564
TOTAL	**21,028,960**		**2,156,299**	**18,872,661**

Table 2: Summary of all activities by center allocation in 2011

Center	**Maintenance & distribution**	**One-time activities: Optimizing**	**One-time activities: Regeneration**	**CENTER TOTAL**
AfricaRice	342,515	164,780	0	507,295
Bioversity	970,932	242,981	0	1,213,913
CIAT	2,394,585	1,969,131	118,215	4,481,930
CIMMYT	1,165,430	0	789,726	1,955,155
CIP	3,231,248	788,198	551,893	4,571,339
ICARDA	1,299,908	0	54,748	1,354,657
ICRISAT	2,464,419	0	158,559	2,622,978
IITA	1,130,621	245,209	164,883	1,540,713
ILRI	840,763	390,053	0	1,230,815
IRRI	1,393,625	0	156,540	1,550,165
Total	**15,234,045**	**3,800,352**	**1,994,564**	**21,028,960**

Additional / associated costs not included in this request

The above financial allocation would finance only a portion of these centers' total costs of the genebank operations. What is excluded, for reasons that are clarified below, are (i) associated management and technical support costs linked to the maintenance and distribution component above, such as training programs, public relations, networking with NARS, participating in international for a and meetings, etc. and, (ii) costs for other genebank operations that are important but which are not, strictly speaking, associated with the essential operations of maintenance and distribution – i.e. those aspects defined as the CGIAR system's "service to mankind". These are research-oriented, such as pre-breeding, research on the collections themselves, and so on. Much of the latter activity can be financed in the context of CRP budgets, as well as existing restricted funding. Some has been financed traditionally by unrestricted support, but it is the intention in the future to not include the majority of such activities in the financing request from the Fund window 1 allocation; most of these activities should be subsumed within the research programs. As 2011 is a transitional year, however, the genebank costs that have do not have sources of project funding (CRP or other) will be covered by a combination of this proposed allocation, and a part of the funding requested separately as the "stability financing" for 2011. The rough estimate of costs described in point (i) above is $3 million. The reason that this element is not included in this request is because at the moment it is an estimated total for the CGIAR system, and its distribution across the centers is not known with precision as it was not specifically a focus of the genebank costing study. For 2011, these costs will be captured and accounted for in the "stability financing" proposal which is a separate request for unrestricted funds in this transition year. In 2012 and beyond, this element will be fully described and costed in detail at the center level and will be included in the financing plan update for the gene bank financing.

Other exclusions

The study did not include the collection maintained by the World Agroforestry Centre as, with the exception of only a very few accessions, the Centre has not taken on a legal obligation for their maintenance. Additionally, animal genetic resources including livestock and fish, were also not considered in the costing study, and therefore there is at present not a firm basis for calculating the cost of maintenance and distribution of these genetic resources. This additional element of CGIAR resources will be addressed in a further study as soon as possible.

Long-term requirement and expectation

There will be an annual financial requirement from the Fund for the maintenance and distribution activities, and that these costs will fluctuate from year to year. However, the requirement from the Fund should also decrease over time. The fluctuations will occur due to inflation and capital investment needs (increases) and specific circumstances that will change the calculated "steady-state" level of financing as determined in the costing study (increases or decreases, depending on circumstances, local labour costs, productivity changes, changes in management structures and costs, and so on). Second, there hopefully will be annual increases in the support level from the GCDT, the level of which will depend on the Trust's endowment growth and the investment returns from the endowment. The different activities and the proposed financing plan for them over time are shown in table 3.

Table 3: Components of support requirements for 2011-2013 and source of financing

	2011 request				2012 estimate				2013 estimate			
	Fund		GCDT		Fund		GCDT		Fund		GCDT	
ACTIVITY	source	$m	source	$m	source	$m	source	$m	source	$m	source	$m
Maintenance and distribution	yes	13.08	yes	2.16	yes	13.34	yes	2.20	yes	13.61	yes	2.24
One-time - Optimizing	yes	3.80	no	0.00	yes	3.88	no	0.00	yes	3.95	no	0.00
One-time - intro from Regeneration	yes	2.00	no	0.00	yes	2.04	no	0.00	yes	2.08	no	0.00
TOTAL		**18.9**		**2.2**		**19.3**		**2.2**		**19.6**		**2.2**

The Consortium Board will annually update, in a financing plan process, the request for support of this core activity, which is a fundamental responsibility of the CGIAR system, from the Fund.

PART B EXECUTIVE SUMMARY (The Cost to the CGIAR Centres of Maintaining and Distributing Germplasm)

Plant genetic resources conserved in the CGIAR genebanks underpin the Centres' breeding programs and supply breeders, researchers and farmers throughout the world with a broad diversity of crops and their wild relatives. The Global Crop Diversity Trust was created to help fund important collections in perpetuity, including those of the CGIAR Centres. While in the longer term the Trust aims to support, from its endowment fund, the essential operations of the CGIAR genebanks (as well as those of other important collections that require external support), until the endowment has built up sufficient funds, co-funding by the Trust and donors to the CGIAR Consortium will be required to accomplish this task. Given the international legal obligation of the Centres to maintain the collections to international standards and to make them available without restriction, it is important that the Consortium have an accurate estimate of the costs involved so that the necessary funding can be guaranteed as a matter of priority[1]. From the Trust's perspective, it is critical that these costs be known accurately so that it can determine the size of the endowment needed. Recognizing the mutual need for accurate costing of the essential genebank operations, the Trust and Consortium co-funded a study to understand and determine the true cost of maintaining the genetic resources and making them available.

APPROACH
To ensure comparability between Centres and crops, a common list of activities essential to the maintenance and distribution of existing collections was developed. It included:

- Acquisition: bringing new material into the collection – at an annual rate of 1% per year of the 2010 total accessions (i.e. not compounded), plus known new acquisitions resulting from the Regeneration Project;
- Characterization: only essential passport and characterization data have been included, primarily those used for accession identification purposes. Molecular characterization was largely excluded except for clonal crops for which the identification and elimination of unwanted duplicates are important;
- Safety duplication, including, where appropriate, the cost of preparing material to be sent to the Svalbard Global Seed Vault;
- Preservation of vegetatively-propagated crops: *in vitro* conservation, cryopreservation, field genebanks, collections of lyophilized leaves and true seed, as appropriate,
- Medium and long-term seed storage;
- Regeneration;
- Germination testing, seed processing and germplasm health testing (including disease cleaning where needed);
- Distribution, including compliance with international agreements and regulations;
- Information management for genebank operations and for making information about the collections widely available electronically;
- General management, including professional staff costs.

A number of important and in some cases critical items for the effective operation of a genebank were not included, as they did not directly relate to the maintenance and distribution of existing material. These included, *inter alia*: collecting new material, identification of duplicates (except in the case of some collections of vegetatively-propagated crops), evaluation, pre-breeding, research on conservation methods, networking, providing international leadership, training and

[1] The study did not include the collection maintained by the World Agroforestry Centre as, with the exception of only a very few accessions, the Centre has not taken on a legal obligation for their maintenance.

public awareness. These operations are, however, much harder to cost in any standardized way and generally have far greater elasticity than the operations covered in this study.

Using financial data provided by the Centres, the cost of each of the above activities was obtained for each collection in each Centre using a recently developed crop genebank Decision Support Tool (see annex 3 for a description of this tool). For comparability, costs were determined on a per accession basis and were divided into recurrent costs (costs for activities that take place every year or that could be annualized) and "one-off" costs that occur only once (at least in theory) in the "life" of an accession, such as acquisition, characterization and introduction into *in vitro* or cryopreservation. Other one-off costs for the overall optimization of the collection were also considered, such as the need to eliminate backlogs in regeneration, or to bring all of a collection into long-term storage. Centres maintaining collections of the same crops were compared to determine any underlying factors leading to differential costs and to rationalize among Centres to the extent possible. However, a complete comparison of costs between similar collections at different Centres was not feasible in this study due to numerous complicating factors. For example, collections such as wheat maintained at two different Centres have different internal uses, outside clients, structures, composition and purposes, and they operate in very different institutional environments with respect to such things as wage and salary scales, costs for electricity and other services, and size of operation.

Overhead and capital costs were taken into account to the fullest extent possible however methods to fully recover costs have not yet been implemented at all genebanks. On those Centres that have, some discrepancies prevail in the details that are impractical to address in this study. An example is costing the full direct cost of computers when they are only partly used for management of the genebank's accessions. A detailed consideration of the cost of all current and future capital costs for the genebanks was also beyond the scope of this study, in view of the many and complex variables associated with technology, new unit costs, the establishment of a replacement fund, etc.

It became clear in the study that the most important factor affecting the individual accession cost, apart from the overhead of the Centre and one-off activities, was the periodicity of regeneration and associated activities such as germination testing and seed health testing. These activities have high labour costs associated with them. Any means of extending the period between regenerations such as regenerating larger seed quantities, distributing smaller seed quantities and ensuring optimal storage conditions to preserve viability should reduce costs significantly.

Vegetatively-propagated crops such as Andean root and tuber crops, banana, cassava, potato, sweetpotato and yam, incur significantly higher costs per accession than seed crops, due in large part to the large amount of skilled labour required for *in-vitro* conservation. Alternative methods of long-term storage such as a greater use of cryopreservation or true seeds should reduce costs overall, but in most cases further work is required to develop robust protocols. In the case of true seed, only alleles would be conserved, not genotypes.

In addition to these annualized costs, there are a number of one-time costs that need to be covered over the next few years in order to 'optimize' collections, for example bringing material that is currently held under medium-term storage conditions into long-term storage, and cryopreserving those materials that are currently held only *in vitro* and for which there are sufficiently robust cryopreservation protocols. While the list of such one-time costs is not necessarily complete, those listed are somewhat conservatively estimated to total approximately US$11.5 million across all of the genebanks. There are also considerable one-time costs associated with bringing material from the Regeneration Project into the collections, estimated to total about US$6 million.

In spite of the limitations of the study mentioned in the report, the consultants believe the results represent an important step forward in understanding the real costs of maintaining and distributing the Centres' germplasm collections and associated information. However, it should be noted that what is provided is a snapshot of costs at this particular point in time. The situation is not static and will continue to evolve. For example, most of the collections are expected to continue to increase in size – by about 7.5% between now and 2015 - although it might be possible to reduce the size of some by eliminating duplicates. The study predicts that the total size of the collections will reach almost 756,500 accessions by 2015, requiring a total annual funding of US$15.93 to maintain. The collections are also expected to acquire proportionally more accessions of wild relatives, and these are generally more difficult and expensive to maintain than cultivated accessions. It might be possible to reduce the cost of clonal collections through a greater use of cryopreservation, true seed and other technologies but in many cases this will require further research and a considerable up-front expenditure before any cost savings can accrue. While the costs of molecular characterization are expected to fall, the need might well increase for more virus and other disease elimination through indexing and cleaning. For these and many other reasons, it will be important that the Consortium, the Trust and genebank managers continue to monitor costs over the coming years.

PART C Management, performance measurement and reporting

The genebank initiative and funding of the project itself in 2011 will be subject to oversight from the Consortium and the Global Crop Diversity Trust, which has been partnering with the CGIAR centers for several years now, and which has a proven track record of monitoring and performance assessment as a consequence and requirement of their granting process. Throughout 2011, the Consortium and the Trust will work together to develop a robust and appropriate management and oversight structure for genebank management in the CGIAR. The Trust co-sponsored (with the Consortium Office) and participated in the technical assessments during the genebank costing project and therefore is in a unique position to assist the Consortium in this regard going forward.

As an interim measure for 2011, it is proposed that the same standards and mechanisms that the Trust employs for performance measurement and reporting for their traditional assistance to the CGIAR should be used for this much larger project, since the activities that are being financed with the funds are for the same purposes – albeit on a larger scale – as the Trust support in the past.

Annex 3 provides a summary of the performance measurement and reporting tools that are proposed for this activity. The centers are well accustomed to these and the Consortium and Trust believe these are perfectly appropriate under the current circumstances. The Consortium will report to the Fund donors as appropriate the results and achievements of the CGIAR system genebank operations in 2012.

Annex 1

Summary of Annual Costs (in US$) for Maintaining and Distributing the CGIAR Germplasm Collections

	Annual recurring cost per accession	Total Annual recurring cost	Annual cost for additional 1% accessions	Total annual capital costs	ANNUAL TOTAL COST	Adjusted by 2% for Inflation
AfricaRice						
Rice	10.06	201,147	14,858	119,794	335,799	**342,515**
Bioversity						
Banana and Plantain	652.50	846,946	41,492	63,456	951,894	**970,932**
CIAT						
Beans	19.48	699,226	90,407	177,521	967,154	**986,497**
Cassava	71.88	473,806	25,687	102,552	602,044	**614,085**
Tropical Forages	26.82	620,664	0	157,770	778,434	**794,003**
Centre total		1,793,696	116,094	437,843	2,347,632	**2,394,585**
CIMMYT						
Wheat	16.96	473,499	107,984	28,072	609,555	**621,746**
Maize	3.28	418,863	34,805	79,335	533,023	**543,683**
Centre total		892,362	142,789	107,407	1,142,578	**1,165,430**
CIP						
Andean R&T	146.50	171,987	9,179	16,289	197,455	**201,404**
Potato	171.49	1,236,951	86,319	149,284	1,472,554	**1,502,005**
Sweet Potato	151.75	1,230,335	159,630	107,896	1,497,881	**1,527,839**
Centre total		2,639,273	255,128	273,469	3,167,890	**3,231,248**
ICARDA						
Barley	5.65	151,685	16,362	43,295	211,342	**215,569**
Chickpea	6.09	81,953	10,681	35,358	127,992	**130,552**
Faba Beans	6.09	55,892	6,180	49,811	111,883	**114,121**
Forage and Range	6.72	165,248	0	82,921	248,169	**253,132**
Grasspea	6.03	19,347	1,872	11,815	33,034	**33,695**
Lentil	6.09	67,014	6,986	22,975	96,975	**98,915**
Pea	6.03	36,614	4,688	18,504	59,806	**61,002**
Wheat	7.14	283,703	24,303	77,213	385,219	**392,923**
Centre total		861,456	71,072	341,892	1,274,420	**1,299,908**
ICRISAT *						
Chickpea	10.74	217,743	21,446	30,815	292,354	**298,201**
Groundnut	12.74	196,838	18,630	26,939	422,607	**431,059**
Pearl Millet	12.49	277,332	35,107	28,811	540,570	**551,381**
Pigeon Peas	12.86	175,356	22,277	17,688	245,221	**250,125**
Small Millet	15.75	161,182	20,346	12,164	227,992	**232,552**
Sorghum	10.20	387,122	47,484	48,547	687,353	**701,100**
Centre total		1,415,573	165,290	164,964	2,416,097	**2,464,419**
IITA						
Banana	66.24	19,209	0	9,317	28,526	**29,097**
Cassava	70.00	194,817	7,516	62,331	264,664	**269,957**
Cowpea	11.15	185,359	20,072	223,578	429,009	**437,589**
Maize	12.12	10,638	1,545	16,301	28,484	**29,054**
Misc. Legumes	11.78	51,184	4	47,488	102,674	**104,727**
Yam	63.93	214,797	11,436	28,862	255,095	**260,197**
Centre total		676,004	40,573	387,877	1,108,452	**1,130,621**
ILRI						
Tropical Forages	32.95	623,449	0	200,828	824,277	**840,763**
IRRI						
Cultivated Rice	7.36	782,571	123,566	205,485	1,111,622	**1,133,854**
Wild Rice	21.27	95,672	19,997	139,008	254,677	**259,771**
Centre total		878,243	143,563	344,493	1,366,299	**1,393,625**
SYSTEM TOTAL		**10,828,149**	**990,859**	**2,442,023**	**14,935,338**	**15,234,045**

***** ICRISAT: Total collection costs include costs (US$670,270) of maintaining collections in Africa

ANNEX 2

One-time costs requiring financing over several years

	Optimizing the collection		Introducing accessions from Regeneration Project		Center
Center	Activity	Cost	Activity	Cost	Total
AfricaRice	processing 8000 accessions from medium to long term storage	494,339			**494,339**
Bioversity	cryobanking/safety duplicating 464 accessions	728,944			**728,944**
CIAT	regenerating 16191 bean accessions; cryobanking 1000 cassava accessions; regenerating 9259 forage accessions	5,907,393	bean and cassava introductions	354,644	**6,262,037**
CIMMYT			maize and wheat introductions	2,369,177	**2,369,177**
CIP	cryobanking 750 potato & 750 SP accessions & health testingin vitro materials	2,364,595	potato and sweet potato introductions	1,655,678	**4,020,273**
ICARDA			barley, faba bean, grasspea, and lentil introductions	164,245	**164,245**
ICRISAT			pearl millet, small millet, and sorghum introductions	475,678	**475,678**
IITA	health testing 13303 cowpea accessions; safety duplication 300m maize accessions	735,626	Bambara groudnut, cowpea, maize, and yam introductions	494,649	**1,230,275**
ILRI	processing 4000 forage accessions into long term storage	1,170,158			**1,170,158**
IRRI			rice introductions	469,620	**469,620**
TOTAL		**11,401,055**		**5,983,691**	**17,384,746**

ANNEX 3

(the following is an excerpt from the Global Crop Diversity Trust 2009 Technical Report for Performance Indicators, reproduced with permission from the GCDT, and to be employed in the CGIAR 2011 genebank project in collaboration with the GCDT)

Performance Indicators: Measuring Progress of Genebanks

Introduction
Performance indicators (PIs) are an attempt to succinctly measure progress over time, towards achieving a goal. Ideally, PIs represent a quantitative measure of quality of a process or operation. They allow an analysis of trends and are usually agreed upon by the organization or community of practice that is using them. PIs should help an organization improve its performance in achieving an agreed-upon set of goals.

Performance indicators were originally developed and employed by the business community but
have now become popular tools for monitoring and evaluation in the public sector, perhaps because it is theoretically possible to capture the essential features of complex systems using relatively simple, quantitative indices.

Trust needs and PI development
When the Trust initiated its long-term grant (LTG) programme in 2007, it became apparent that a need existed to develop performance indicators to assess the effectiveness of the grants the Trust was providing. These were not 'normal' grants in that they didn't have deliverables, outputs and milestones as most fixed-term grants do. The long-term grants provided annual funds for the genebanks to use to conserve key priority crops - essentially "business as usual". Therefore, the Trust needed to develop a set of performance indicators that provided the ability to see annual progress and performance across a range genebank specific goals. Genebanks perform two central roles:

1. Conservation of crop germplasm and recording of associated information; and
2. Distribution of crop germplasm and associated information.

The Trust also expects the long-term grantees genebanks to perform a third role, that of
3. *Contributing to the development of a global system*

Although the CGIAR began applying performance indicators a number of years ago, they were very broad and did not include specific indicators for genebank operations. Their use was primarily to enhance programmatic, institutional and financial performance and it was clear that they were not sufficient for meeting the needs of the CGIAR genebanks and it was agreed that a specialised set needed to be developed.

In 2007 when the Trust began developing their genebank indicators, the *Global Public Goods 2* (*GPG2)* also began a new activity under the System-wide Genetic Resources Program of the CGIAR that was aimed at designing genebank performance indicators for the reasons described above. The two groups joined forces and the Trust based its initial set on work undertaken during a *GPG2* workshop in Lunteren, Germany in 2007, which the Trust attended and contributed to.

The genebank performance indicator development work took place over a 3-year period. The Trust, building on the work coming out of the Lunteren workshop, further developed a set of PIs for assessing performance (primarily requiring quantitative data) that were utilised by partner CGIAR genebanks over a three year period as part of their annual long-term grant reporting to the Trust. Their reports were submitted in May each year and were followed by a review period each year. In parallel, *GPG2* further developed their set of PIs (these could be described as diagnostic indicators that were more focused on processes than performance) that were tested by 3 genebanks. A number of times these PI activities came together for alignment where possible (recognising the same genebank community were involved).

Harmonisation
In 2009 the CGIAR genebank managers requested only one set of genebank PIs be used and recommend the Trust set be used as they had all actively been involved in their development and testing. As a result, the two streams were completely harmonized in January 2010 and the Trust set was adopted (http://cropgenebank.sgrp.cgiar.org/index.php?option=com_content&view=article&id=140&Itemid=241&lang=english). It should be noted that these genebank performance indicators are also being used by a non-CGIAR genebank that is also a recipient of a long-term grant from the Trust with success.

Further development
Obviously, goals change and PIs need to be reviewed on a periodic basis. The Trust recognizes the need to balance further evolution in performance indicator development against the value of continued reporting over time against a stable set of indicators. Currently, the Trust plans only to
focus on the resolution of issues surrounding the more intangible performance indicators (such as collaboration and leadership in crop conservation and improving the coverage of the genepool ex situ) with the view to improving these indicators. This is planned to be undertaken with the genebanks in 2011.

Performance Reporting Format

Annual technical and financial reports cover the calendar year of grant allocation up to 31 December and shall be submitted to the Trust Secretariat by 31 May of the following year. Reports should be written in a clear, simple style and in English. Reports shall be submitted in three copies, plus a readable word processing file (preferably MS Word file or if unavailable a PDF file).

Reports shall contain the following information:

1. Multi-year budget

Reports shall include a four year rolling multi-year budget, developed within the first year of the grant that reflects the grant commitments in Articles 2 and 3.

2. Brief narrative summary of progress

a) Please describe progress made towards achieving the grant purposes outlined in the Grant Agreement (Article 3) or any proposal amendment submitted thereafter.

b) Briefly describe the activities carried out during this reporting period and provide supporting data as appropriate.

c) Address the question: “what is the impact of the grant so far?”

3. Deviations from the project multi-year budget and purposes

a) Please document where activities differ from the multi-year budget and grant activities explaining the consequence of deviations and what was done to alleviate them. Include any technical issues that have arisen.

b) Please describe variances in budget line items that exceed 10% in either direction.

4. Case studies, innovation or success stories

a) Please provide detail on any case studies, good practice and innovation or success stories the Trust could use to publicize the achievements and works of the grant.

5. Progress against performance indicators

a) Drawing upon the GPG2 performance indicators under development by the CGIAR, the Trust wishes to see progress reported against a subset of indicators. Please provide a response for each performance indicator.

ANNEX 4

The Cost to the CGIAR Centres of Maintaining and Distributing Germplasm

Acknowledgements

The Consultants responsible for of this report[2] wish to thank the Consortium Office, and in particular Carlos Perez del Castillo and Anne-Marie Izak, as well as the Global Crop Diversity Trust, especially Cary Fowler, Melissa Wood, Jane Toll and Hang Nguyen for initiating this study and for their support and encouragement throughout. Our thanks are also due to all the genebank managers, finance staff and others at the Centres who helped prepare the basic financial and other data needed and who so painstakingly described and explained their various genebank operations.

We would also like to give a special recognition and thanks to the work of two individuals in particular, without whom this report would not have been possible:

Daniela Horna: who developed the Decision Support Tool that was used extensively as a source of information regarding the costs of various genebank activities. Daniela had originally developed the tool as part of her work at IFPRI within the context of the SGRP Global Public Goods Project. She provided invaluable support in helping the genebank managers and staff to enter accurate data into the tool, continually adjusted and fine-tuned the tool to meet the specific purposes of the exercise, and generated reports that we were able to use as a baseline for the analyses.

Charlotte Lusty: who worked tirelessly with the Centres and us before, during and after the meetings in Rome to get data that were both relevant for our purposes and as accurate as possible, and to work the output of the costing tool into the tables that were the basis of this report. The insights that she was able to provide into the operations of the individual genebanks as well as their costs were also invaluable and very much appreciated.

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1. Introduction:

1.1 Origin and need for the study

Plant genetic resources conserved in the CGIAR genebanks underpin the Centres' breeding programs and supply breeders, researchers and farmers throughout the world with a broad diversity of crops and their wild relatives. Given the international legal requirement that the Centres maintain the collections to international standards and make them available without restriction, it is important that the CGIAR Consortium have an accurate estimate of the costs involved in meeting these obligations so that the necessary funding can be guaranteed as a matter of priority.

The Global Crop Diversity Trust's mission is to eventually fund the essential conservation and distribution activities of all of the CGIAR genebanks, as well as other key germplasm collections around the world that need its support. In order to fulfil its mission, it is critical that the Trust know the size of the endowment that will eventually be needed to cover these costs in perpetuity.

The CGIAR Change Process has resulted in major structural and financial changes. The mechanism for how the genetic resources of the CGIAR will be funded in the future is still being debated within the new Consortium and CGIAR Fund, but it is clear that special/unique

[2] See Annex 2 for the consultants' biodata.

arrangements will be needed to ensure financial continuity regardless of changes in CGIAR programming that occurs over time. As the funding from the Trust is currently insufficient to cover all the needs of the genebanks, additional funding will, for some time, still be required from the Fund and other sources.

Previous estimates of the costs involved have varied widely and it has become urgent that accurate and up-to-date information be obtained on the true cost of conserving and distributing the CGIAR germplasm collections as well as the information on them. This study attempts to generate such information.

1.2 Previous costing studies

An important study on the economics of conserving crop genetic resources in five of the CGIAR genebanks was undertaken in the early 2000s (Koo et al, 2004)[3], but it became increasingly clear that an accurate costing of all the genebanks across the CGIAR was needed. A study was carried out in 2009 to cost selected key conservation and distribution activities in a study of the financial needs for sustaining the genebanks following the injection of funds made through the World Bank's Global Public Goods One and Two projects (GPG1 and GPG2)[4]. However, it proved to be extremely difficult to arrive at costs that are truly comparable across the CGIAR system as a result of the different cost structures and accounting procedures that are used at the different Centres. It was apparent that further work was needed to try to arrive at costs that are more comparable.

Since the study of Koo et al., many factors have changed, and in particular there has been a significant increase in the number of accessions held by the Centres. In addition they have experienced differential inflation and currency exchange rates. While the CGIAR Centres' budget, and international research scientists are paid in US dollars, local salaries and wages as well as many supplies and services are paid for in the local currency. Large currency value changes have often impacted on the financial capacity of the genebanks.

The costs of genebank operations have also increased as a result of additional international requirements for phytosanitary permits as well as the need to manage material transfer agreements and declarations on the presence of GMOs. Additional safety backups at other locations, including the recently constructed Svalbard Global Seed Vault (SGSV), have also increased costs.

New technologies for monitoring the genetic integrity and uniqueness of accessions, while important and having the potential to reduce costs in the future, have in many cases added to the immediate costs of conservation, and much more work is needed in this regard. For the conservation of clonal crops, cryopreservation offers a means to store genetic resources for extended periods of time with minimal losses of viability. However, the additional costs of achieving such security include not only getting the material into (the vapour phase of) liquid nitrogen - often a difficult and expensive process - but also the on-going cost of liquid nitrogen, an efficient infrastructure for dispensing it, and the purchase of expensive cryotanks and their future refurbishment. Meanwhile, it is still necessary to store collections in the previous forms such as in field genebanks, *in vitro* or as seed. Several collections are in a transition phase.

Computer and database technologies have added significantly to the functionality of the maintenance and distribution of genetic resources. Staying current with the programming and

[3] Koo, B, PG Pardey and BD Wright. 2004. Saving Seeds: the Economics of Conserving Crop Genetic Resources Ex Situ in the Future Harvest Centres of the CGIAR. CABI Publishing. Kings Lynn, UK and Cambridge, Massachusetts

[4] Upgrading the Genebanks of the CGIAR. Global Public Goods Rehabilitation Project 1, Phase 1. Final Report, 2006. Systemwide Genetic Resources Program, IPGRI.

addition of high-speed equipment to manage the large collections at the Centres has been critical. The Global Crop Diversity Trust has been investing in a significant upgrading of an international genetic resources information management system.

The International Centres have recently changed accounting practices to establish budgets that include all indirect and direct support costs. Earlier CGIAR genebank studies were not able to take account of all such costs and their inclusion in this study represents a substantial component of the overall cost structure and financial requirements reported here.

1.3 Objectives of the study

The objective of this study is to determine, in a standardized, uniform way, the costs of conserving the important international plant germplasm collections that are maintained *ex situ* by the Centres of the CGIAR, managing them to international standards and making them and the information about them available under the terms of the International Treaty on Plant Genetic Resources for Food and Agriculture. The full terms of reference are given in Annex 1.

1.4 Overview of the collections

Up-to-date information about the collections was obtained from the genebank managers at all CGIAR Centres having plant germplasm collections. The collections considered in the study, together with the number of accessions they contain, are given in Table 1. The table shows the size of the collection at the end of 2009 and the number of accessions that are expected to be added to the collection over the next few years, both as a result of normal acquisition (estimated at 1% of the 2010 total added annually) and from the international germplasm regeneration project (referred to as the Regeneration Project) of the Global Crop Diversity Trust, funded through the UN Foundation by the Bill and Melinda Gates Foundation.

Table 1.1. Accessions held in CGIAR genebanks and expected additions from normal acquisition and the Regeneration Project*

Centre	Crop	Number of accessions in 2009	Number of accessions expected from Regeneration Project	Number of accessions expected in 2015
AfricaRice	Rice	20,000	570	21,000
Bioversity	Banana, Plantain	1,298	114	1,412
CIAT	Beans	35,903	2866	38,769
	Cassava	6,592	545	7,137
	Tropical forages	23,140	0	23,140
CIMMYT	Maize including 162 *Teosinte,* 152 *Tripsacum*	27,440	6,214	33,654
	Wheat including wild *Triticale*, rye and triticale	127,689	7,290	134,979
CIP	Andean roots and tubers	1,174	0	1,264
	Potato	7,213	975	8,188
	Sweetpotato	8,108	871	8.979
ICARDA	Barley	26,856	2,383	29,239
	Chickpea	13,462	408	14,257
	Faba bean	9,181	787	9,968

	Forage and range plants	24,606	0	24,606
	Grass pea	3,210	1165	4,375
	Lentils	11,008	815	11,823
	Pea	6,075	0	6,380
	Wheat	39,762	1,128	41,747
ICRISAT	Chickpea	20,267	723	21,282
(India)	Groundnut	15,445	0	16,215
	Pearl millet	22,211	1,300	23,511
	Pigeon pea	13,632	380	14,312
	Small millets	10,235	1,388	11,623
	Sorghum	37,949	4,054	42,003
ICRISAT**	Chickpea	100		100
(Africa)	Groundnut	14,020		14,020
	Pearl millet	11,389		11,389
	Pigeon pea	1,000		1,000
	Sorghum	8,565		8,565
	Small millets	1,500		1,500
IITA	Banana, Plantain	290	0	290
	Cassava	2,783	0	2,923
	Cowpea	16,629	1118	17,747
	Miscellaneous legumes	4,346	266	4,612
	Maize	878	240	1,118
	Yam	3,360	1,364	4,724
ILRI	Tropical forages	18,291	0	18,291
IRRI	Rice	110,817	9580	120,397
	Totals:	**706,424**	**46,544**	**756,539**

* The totals include material from the regeneration project only when these exceed the anticipated 5-year total of new acquisitions.
** Some, but not all, of the accessions in Africa are also included in the ICRISAT collections in India. They have not been included in the total accessions for the CGIAR as a whole.

The large majority of the accessions in the collections are maintained as seed in cold stores or deep freezers, either or both for the medium-term (generally at +5°C) or long-term (generally at -18°C).

Vegetatively-propagated crops, however, such as the Andean root and tuber crops, banana, cassava, potato, sweetpotato and yam are maintained primarily *in vitro*. They are much more expensive to maintain and often a combination of techniques is employed that includes *in vitro* storage, cryopreservation, true seed, field genebanks, lyophilized leaf tissue, or extracted DNA. They also often have disease problems (especially viruses) that can restrict their distribution.

Collections of several crops are maintained by more than one Centre, e.g. banana at Bioversity and IITA, cassava at CIAT and IITA, chickpea at ICARDA and ICRISAT, maize at CIMMYT and IITA, rice at AfricaRice and IRRI, tropical forages at CIAT and ILRI and wheat at CIMMYT and ICARDA. This is a result of: the historical development of the collections; different structure, and uses of the collection; different collection compositions (e.g. regional *vs*. global collections); or as a result of quarantine restrictions that limit germplasm movement (especially between continents). The threat of introduced wild relatives becoming invasive can also dictate the location of certain collections. In reality, however, there appears to be relatively little replication of materials among Centres, except for intended safety duplication.

2. Methodology

2.1 Centre data and the costing tool

The study to determine the true cost of maintaining genetic resources in CGIAR genebanks involved collecting and reviewing certain genebank cost information from 10 CGIAR Centres, for some 670,000 accessions representing 32 separate crops or crop groups (the full list of accessions in each collection is shown in Table 1). Data for the study were generated at the relevant centres and entered into a financial model called the Decision Support Tool (DST)[5], which was developed within the GPG2 Project. The tool, a brief description of which is given in Annex 3, is used to provide information on the costs of individual genebank operations as well as to generate reports on the overall cost of operating a genebank in a given year. The tool is designed to assist genebank managers make critical management decisions and to optimize the efficiency of their operations. The tool proved to be of great value in the current costing study.

The following resource data were collected to feed into the model:

- The crops, and number of accessions for each, in storage at each centre;
- The capital cost of facilities/infrastructure, as well as associated financial information such as the acquisition date and service life of infrastructure and equipment, and country inflation and discount factors for determining present value of the capital stock;
- The capital cost of all equipment needed for the genebank (not only equipment capitalized by Centres in accounting terms, but all equipment regardless of cost, but excluding supplies);
- The permanent staff costs associated with relevant genebank operation ("quasi-fixed costs" in the model);
- Variable costs for labour – wages or fees paid to temporary workers and others such as consultants who worked within a given year;
- Non-labour variable costs – these include various operating expenses including supplies, office and lab expenses, travel, computer charges, facility cost charges, farm operation expenses, and so on.

The model requires that these costs be assigned to the different crop collections in each genebank. Additionally, for each crop or crop group, the model requires that costs be assigned to a range of activities (examples: acquisition, characterization, long-term storage, etc.) that describe the actual work within the genebank. The full list of activities considered is shown in the detailed centre-by-centre tables in Annex 5. The raw data used in the study to generate the annualized per-accession and total collection costs are given in Table 2.1.

It should be noted that the figures in Table 2.1 are not the total budgets of the Centres' genebanks, because the request for information specifically asked for certain data to not be included (see section 2.3 below). Furthermore, even the totals will not necessarily add up to the value calculated for each genebank as the sum needed for annual maintenance of the collection, because it is not possible, for reasons described later, to simply divide the total of the genebank costs by the number of accessions to get a realistic estimate of an annual per-accession cost of maintaining the collection; the objective of this study.

Similarly, the number of senior person-years shown above is not necessarily the total of those senior staff costs in the genebank – these are the proportions that are relevant only to

[5] See: http://cropgenebank.sgrp.cgiar.org/

the set of activities regarded as essential conservation, information and distribution activities as defined for this study.

Table 2.1 Summary of the 2009 genebank financial information used to determine the annual cost of maintaining the genebank by Centre*

			Costs ($'000)					
			Quasi-	Variable		Capital		
Center	# crops/groups	# accessions	Fixed	Labour	non-labour	Facilities	Equipment	TOTAL
AfricaRice	1	20,000	163	94	149	23	102	**531**
Bioversity	1	1,298	579	7	455	0	63	**1,104**
CIAT	3	65,635	1,251	115	997	298	148	**2,809**
CIMMYT	2	155,129	463	92	517	31	79	**1,182**
CIP	3	16,495	1,693	28	1,616	46	247	**3,630**
ICARDA	8	134,160	552	102	489	82	261	**1,486**
ICRISAT	6	156,313	1,062	106	892	72	93	**2,225**
IITA	6	28,286	550	140	311	135	263	**1,399**
ILRI	1	18,291	243	165	324	81	120	**933**
IRRI	1	110,817	629	30	384	271	73	**1,387**
TOTAL			**7,185**	**879**	**6,134**	**1,039**	**1,449**	**16,686**

*Not including the cost of ICRISAT's regional (African) collections.

2.2 Understanding, interpreting, and refining the data

The Centres' financial information for the year 2009 comprised the most recent complete data available. In a few cases, data from 2008 or 2010 were used to "complete the picture" in order to generate the operating cost of a "typical" current year, if for some reason data from 2009 were incomplete or significantly atypical.

It is important to understand that the "raw data" that entered the model and that generated a cost total of each centre's genebank operation:

- Cannot align perfectly with the results that this study generates as the best estimate of the cost of the basic operation of the genebank; and
- Are not the institutional budget for any genebank.

The reasons for the above caveats are that the project required (1) that only certain genebank costs be included in the model (2) that in analyzing the data it became clear that arriving at a constant level of activity that is defined as a permanent steady state of material maintenance does not require all activities to be undertaken in all years, and (3) that the capital costs are calculated and expressed in present value terms – that is, in order to produce the annual costs of the genebank, current prices for equipment and infrastructure are converted to nominal prices using Consumer Price Index information already entered in the tool and annualized using the relevant discount rate.

The most important interpretive actions that were needed involved face-to-face discussions with each genebank manager, and all were interviewed during this study. Clarification of all aspects of the genebank operation, including which costs should be included or excluded from the calculation of the basic cost per accession, was possible during these intensive discussions (and, in some cases when additional questions arose during further analysis, in writing after the manager had returned to his/her centre). Where necessary, follow-up discussions with Centre financial staff were also carried out to clarify different aspects of cost treatment (such as full cost methodology), both by written messages and by telephone conversation when more detailed exploration was required.[6]

[6] Gathering and interpreting some of the financial data was, in certain cases, very difficult. Even when the raw data were agreed there were instances where a misunderstanding of purpose lingered: some

2.3 Boundaries: what's in and what's out

As mentioned above, a typical CGIAR Centre genebank operation includes many activities that, while important or even essential, have not been costed in this study because they do not directly involve the conservation and distribution of existing accessions and the information about them. The specific functions covered, and the way they have been addressed in the study, are described in detail in Annex 4. In brief they include:

- Acquisition: bringing new material into the collection – at an annual rate of 1% per year of the 2010 total accessions (i.e. not compounded), plus known new acquisitions resulting from the Regeneration Project;
- Characterization: only essential passport and characterization data have been included, primarily those used for accession identification purposes. Molecular characterization was largely excluded except for clonal crops for which the identification and elimination of unwanted duplicates is important;
- Safety duplication, including, where appropriate, the cost of preparing material to be sent to the Svalbard Global Seed Vault;
- Preservation of vegetatively-propagated crops; *in vitro* conservation, cryopreservation, field genebanks, collections of lyophilized leaves, true seed, DNA collections and herbaria, as appropriate,
- Medium- and long-term seed storage;
- Regeneration;
- Germination testing, seed processing and germplasm health testing (including disease cleaning where needed);
- Distribution, including compliance with international agreements and regulations;
- Information management for genebank operations and for making information about the collections widely available electronically;
- General management, including professional staff costs.

Important genebank functions that have not been considered in this study include:

- Collecting;
- Molecular characterization for the identification of duplicates (except in the case of some collections of vegetatively-propagated crops that are very expensive to maintain);
- Evaluating the germplasm for important traits;
- Pre-breeding;
- Training;
- Research on conservation methodology, reproductive biology, taxonomy, etc.;
- Networking and providing international leadership and facilitation; and
- Public awareness, attendance at conferences, visitors services etc.

In the course of this study, the genebank managers were asked to carefully cost only the relevant activities, and these were discussed where appropriate during the interview and clarification stage. Nevertheless, it is possible that there are some grey areas, or simply that some costs have been inadvertently included that should not have been. The consultants are confident, however, that the impact of any such data errors is minor.

2.4 US$ cost per accession per year, for comparison

In order to be able to compare costs across the system, the cost of each relevant activity was calculated in terms of the annualized cost per accession (taking into account the total cost of the activity and the number of accession involved in the year under study, together with the

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centre financial staff (especially) may have viewed the exercise as much to generate a "funding request" as to define costs. While this is a fundamental misreading of the task, it did lead to lengthy discussion and debate over interpretation of some data, and it led to delays in finalizing the report.

average frequency of the event per accession over years). This annualized accession cost was multiplied by the total number of accessions in the collection to give an overall annual cost of maintaining and distributing the collection. To this was added the annualized capital costs associated with the collection.

The frequency of operation was set largely according to best practice in the individual genebank. Acquisition and distribution rates, however, were influenced by the peculiarities of the year under study. In general, rates of distribution vary widely across Centres and across years within Centres. The collections were, therefore, divided into three subsets according to the quantity of materials that were distributed in 2009, and the frequency of distribution was standardised for each subset (at an average frequency of distribution of 2, 7 or 20 years respectively, per accession). Acquisition rates were also standardised at a rate of 1% of the total 2009 accessions added per year.

The per-accession costs of maintenance and distribution vary considerably depending on the crop, Centre and other factors. Nevertheless, calculating the cost on this basis means there is a simple relationship between the number of accessions and the total cost of the genebank – the "bottom line" objective of the study. It is easy to see, for example, that some genebanks in the CGIAR have relatively few accessions, but may have a relatively high total cost, for perfectly valid reasons, and vice-versa.

2.5 One-off *vs*. recurrent costs

In order to calculate the annualized cost of an accession maintained within a collection functioning in a well-established routine two types of costs were calculated:

a) one-off costs that are only incurred once during the "life" of an accession such as acquisition (entry of a new accession into a collection), characterization (once an accession has been adequately characterized, the exercise does not have to be repeated) and introduction into cryopreservation; and
b) recurrent costs for activities that occur annually (such as maintaining the material in medium- and long-term storage – electricity costs and the like) or that occur at regular and predictable intervals (such as regeneration that may take place only once every 15 – 50 years) and that can be annualized by taking into account the number of accessions involved in any one year.

One-off costs have only been included in the annualized cost estimate for new accessions acquired at a "background" acquisition rate of 1% per year. (But, see 2.9 below).

Many collections, however, are not functioning totally routinely and require additional support in order to optimize the collection. This is particularly the case for *in vitro* collections. In addition, most collections need to deal with backlogs in regeneration, health testing, cryopreservation, etc, The costs of one-time activities such as these have not been included in the annualized costs, but some of the major instances reported to the consultants are provided in Section 4. below.

2.6 Full costs of operation: defining and handling direct and indirect costs

In calculating genebank costs, Centres were asked to ensure that full costs were computed, according to the current CGIAR policy on Full Cost Recovery. Accordingly, in addition to the direct scientific costs, the Centres included a variety of institutional direct costs such as facility use (electricity, security, maintenance, etc.), information technology costs (usually calculated as a full cost assigned to each computer), and other direct support costs. Additionally, the model required that each Centre include its indirect cost rate (overhead) that is then applied to all other components. The results generate a full cost of genebank operation, sorted by crop and by cost component. The summaries of these raw data for each Centre and each crop (sometimes an aggregate of several related species) are given in Table 2.1 above.

We add a word of caution here: although the CGIAR system has developed a methodology for calculating full costs (Financial Guidelines Series No. 5) it is a reality that the pace of adoption and methodological refinement still varies somewhat between Centres. Accordingly, if these costs were to be re-calculated in, say, three years, the full costs at some Centres may be slightly different (probably higher) than the current values, as their full cost recovery methodologies are finalized. Having stated this, the consultants are confident that the results of the study are valid with only minor variances between Centres' results due to internal costing methodologies.

2.7 Capital costs

As the objective of this exercise is to determine the best estimate of current costs of maintaining the materials in a genebank and of distributing them, it is appropriate to include the costs on a "current year" basis. This is a simple matter for operational costs, as these are budgeted annually, and takes into account real-time effects of inflation and currency values. However, bringing the capital costs to the present value requires slightly more effort.

The financial model calculates the present annual value of the capital stock (infrastructure and equipment). In order to produce the annual costs of the genebank, current prices are converted to nominal prices using Consumer Price Index information entered in the costing tool, and annualized using a discount rate requested in the information section of the tool.[7] It is important to take into account that the annualized capital figure:

- Is not the same number that derives from an accounting calculation of depreciation, which simply spreads out the original cost of an item over the life of that item, and which makes no allowance for inflation or present value;
- Is not the replacement cost of the infrastructure or equipment. It is the best estimate, using classical financial calculations, of expressing the capital stock's annualized cost in present value terms. Calculating the cost of replacement of the capital stock is an entirely different exercise, and would take account of changes in technology, new unit costs, and many other factors. (However, as a mechanism for building a cash reserve – i.e. a "capital fund" – using the present value rather than the simple depreciation cost would result in faster cash accumulation).

2.8 Comparative costs

It is always tempting to compare costs of any operation between institutions – in this case the CGIAR Centres – especially for activities that seem, on the surface, to be similar in nature. For genebanks, this is especially a temptation when the same crop or group of crops is housed in different Centres. We add a strong note of caution that such comparisons can lead to incorrect conclusions about efficiency, cost-effectiveness or, especially, musings about combining collections in a single location. There are many reasons why some genebank operations are less or more expensive than others, for example:

- Nature of the collection itself – this may be the most significant single factor;
- Location of the genebank – local labour costs may vary significantly, for example, and if an operation is labour-intensive, this will affect total costs;
- Unit costs differ depending on local markets and circumstances (inflation, local currency valuation, and input costs such as electricity and materials/services, etc.);
- Size of operation – there may be economies of scale affecting total costs;

[7] The discount factor is the average interest rate in the country where the genebank has their bank accounts, but in the case of the CGIAR system these accounts are usually kept in international banking centres (US, Europe, or elsewhere) and so an appropriate rate to use is an "average" interest rate for OECD countries. The discount rate is the interest rate used to find the present value of an amount to be paid or received in the future. This discount rate is used for annualizing the capital costs and also for estimating the in-perpetuity costs.

- Institutional factors such as organizational structure and scale of overall activity may affect cost recovery metrics resulting in different costs at different locations.

2.9 Increasing collection size

The calculation of annualized costs takes into account that the collections are growing. From a discussion with the genebank managers, it appears that the average annual acquisition rate across the system is about 1% of the total 2009 accessions. Although this varies considerably from year to year, and some collections are growing faster than others, this average rate has been used, non-compounded, for all of the individual collection calculations with the exception of those collections which are not expecting to receive any new acquisitions.

The growth in collections has two main consequences:

a) There are annual one-off costs associated with bringing new material into the collections; and
b) Annual costs will grow over time as the collections grow.

A particularly large influx of new material into the collections is expected over the next 1-3 years as newly regenerated materials are sent to Centres from the Regeneration Project. For the purpose of estimating the costs of introducing new material, the sum total of per accession costs for all operations (regeneration, health-testing, seed processing, cryopreservation, etc) is included, except for distribution and routine maintenance in long- and medium-term storage. In some cases where materials are being safety duplicated or originate from other genebanks, a new accession may not need to go through an entire cycle of regeneration, in which case the introduction costs here are a substantial over-estimation of actual costs.

Recognizing that new acquisitions will have a significant impact on overall future annual collection maintenance and distribution costs, the information provided for each Centre gives cost estimates based on the size of the collection at the end of 2009 (corresponding to year of the financial data) as well as estimates based on the size of the collection expected in 2015. [8]

2.10 Contingency

Given the uncertainty surrounding some of the data, it might be wise in any overall calculation of costs to include a contingency of, say, 10% to cover such events as higher rates of acquisition of new accessions than the 1% included in the study, and moves towards generating more, and making greater use of molecular data.

3. Centre x Collection Cost Summaries (Current and 2015)

This section provides summarized information on the annual and one-off costs of maintaining and distributing the germplasm and related information for each of the main CGIAR crop collections in 2009 and 2015. The one-off costs of introducing new materials above the background acquisition rate and for reducing regeneration and other backlogs are given in Section 4.

3.1 Africa Rice

3.1.1 Rice

The AfricaRice collection comprises mainly rice of African origin (approximately 80%) or rice of direct interest to Africa. Approximately 16% of the collection is *Oryza glaberrima* and the

[8] The additional accessions resulting from the Regeneration Project have only been included in the calculation of 2015 collection sizes when these exceed the total background acquisition rate for the five years

rest is mostly *O. sativa* with about 460 accessions of 5 wild species. AfricaRice works closely with IRRI and a number of activities are underway to strengthen this relationship. There is relatively little overlap between the IRRI and Africa Rice collections. Where possible, AfricaRice distributes material (including IRRI materials) within Africa and *vice versa* in Asia. Problems resulting from the move of AfricaRice from Bouake, Cote d'Ivoire to Cotonou remain. For example, efforts are still underway to determine exactly which accessions are available in medium-term storage in Cotonou and in what seed quantities. One third of the collection is held in long-term storage at IITA for AfricaRice, free of charge up until now. The costs of this service, however, will be charged to Africa Rice from 2011. The rest of the collection continues to be processed for long-term storage and the cost for this is included in Section 4.

AfricaRice	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**20,000**	**21,000**
Annual recurring cost per accession	**10.06**	**10.06**
Total annual recurring cost of maintaining existing accessions	201,147	211,205
Annual cost of acquiring 1% additional accessions (non-compounded)	14,858	14,858
Total annual capital costs	119,794	119,794
Total Annual Cost	**335,799**	**345,857**

3.2 Bioversity

3.2.1 Banana and Plantain

Because of the need to locate the collection in a country free from banana diseases, Bioversity International's banana and plantain (*Musa*) collection is maintained at Katholieke Universiteit, Leuven, Belgium in the International Transit Centre (ITC). The collection comprises approximately 1,300 accessions that are maintained *in vitro,* and require sub-culturing every year and refreshing every 10 years (i.e. growing out as plants in the greenhouse, with field testing in the region of origin to check for somaclonal variation, etc.). Approximately 60% of the collection is currently cryopreserved and putting the remaining collection (plus new acquisitions) into liquid nitrogen represents a very significant "one-off" cost (see Section 4). The cost of virus indexing (mostly carried out in Australia) and, where needed, therapy is also very significant. The rationalization of operations (e.g. *in vitro* conservation and rejuvenation) may be possible once the collection is entirely cryopreserved.

Bioversity banana	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**1,298**	**1,412**
Annual recurring cost per accession	**652.50**	**652.50**
Total annual recurring cost of maintaining existing accessions	846,946	921,331
Annual cost of acquiring 1% additional accessions (non-compounded)	41,492	41,492
Total annual capital costs	63,456	63,456
Total Annual Cost	**951,894**	**1,026,279**

3.3 CIAT

3.3.1 Bean

The bean collection maintained by CIAT comprises almost 36,000 accessions, of which approximately 90% are *Phaseolus vulgaris.* The collection also has significant numbers of accessions of *P. coccineus, P. lunatus* and *P. polyanthus* as well as smaller numbers of accessions of many other wild *Phaseolus* species*.* Overall, the cost of maintaining accessions of wild species is not significantly greater than that of accessions of cultivated species. Fifty percent of the collection is held in long-term storage, and regeneration is ongoing to bring the rest of the collection into long-term conservation (see Section 4).

CIAT Beans	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**35,903**	**38,769**
Annual recurring cost per accession	**19.48**	**19.48**
Total annual recurring cost of maintaining existing accessions	699,226	755,043
Annual cost of acquiring 1% additional accessions (non-compounded)	90,407	90,407
Total annual capital costs	177,521	177,521
Total Annual Cost	**967,154**	**1,022,971**

3.3.2 Cassava

The cassava collection at CIAT comprises some 6,500 accessions, mainly of the cultivated species *Manihot esculenta* but with approximately 900 accessions of about 30 species of wild relatives. The number of wild relatives is not expected to increase significantly as long as they remain excluded from the Multilateral System of Access and Benefit Sharing under the International Treaty on Plant Genetic Resources for Food and Agriculture. There is no major overall cost differential between conserving wild and cultivated accessions and all are maintained *in vitro*. A core collection of about 10% of the total collection is cryopreserved. Work is underway to produce a robust protocol for seed production and conservation. CIAT also maintains a “bonsai” collection (small plants maintained in pots in the greenhouse) of approximately 2,000 accessions as a source of tissue for DNA sampling, etc. There is no field collection of cassava at CIAT due to pest and disease problems. Only one third of the collection is safety duplicated in another location. It remains to be decided how to improve the security of the collection and which accessions should be conserved in what form. The costs of cryobanking further accessions are included as a one-off cost in Section 4.

CIAT Cassava	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**6,592**	**7,137**
Annual recurring cost per accession	**71.88**	**71.88**
Total annual recurring cost of maintaining existing accessions	473,806	512,978
Annual cost of acquiring 1% additional accessions (non-compounded)	25,687	25,687
Total annual capital costs	102,552	102,552
Total Annual Cost	**602,044**	**641,217**

3.3.3 Tropical Forages

The CIAT tropical forage collection of over 23,100 accessions is largely made up of Latin American forage legume species mostly from the lowland tropics (below 1200m). In addition there are approximately 2,200 African grasses and just over 800 accessions of multi-purpose trees and shrubs (mostly leguminous). Currently, only about 40% of the accessions are maintained in long-term storage. The rest are undergoing regeneration, the costs for which are included in Section 4.

CIAT Tropical forages	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**23,140**	**23,140**
Annual recurring cost per accession	**26.82**	**26.82**
Total annual recurring cost of maintaining existing accessions	620,664	620,664
Annual cost of acquiring 1% additional accessions (non-compounded)	0	0
Total annual capital costs	157,770	157,770
Total Annual Cost	**778,434**	**778,434**

3.4 CIMMYT

3.4.1 Maize

The maize collection comprises some 27,440 accessions of which about 300 are of wild *Tripsacum* and *Teosinte* species. Perennial teosintes are maintained in field collections, which along with *Tripsacum* spp., are significantly more expensive to maintain than cultivated maize accessions. The collection has relatively few accessions of African origin and about 500 of 900 accessions of the IITA collection are currently available in CIMMYT. The remaining accessions from the IITA collection will also be sent to CIMMYT. Maize is an expensive crop to maintain, in part due to the need to bag inflorescences to control crossing. A small but increasing number of accessions in the collection cannot be easily regenerated in environments in Mexico. The intention is to regenerate such high altitude dependent accessions at a high-altitude location in the Andes and the estimated costs for this have been included in Section 4.

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CIMMYT maize	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**27,440**	**33,654**
Annual recurring cost per accession	**16.96**	**16.96**
Total annual recurring cost of maintaining existing accessions	473,499	605,581
Annual cost of acquiring 1% additional accessions (non-compounded)	107,984	107,984
Total annual capital costs	28,072	28,072
Total Annual Cost	**609,555**	**741,637**

3.4.2 Wheat

The CIMMYT wheat collection comprises almost 130,000 accessions, with a focus on breeding lines, cultivars and genetic stocks. However, there are many near duplicates (in part due to regenerated material, in the past, having often been included as a new accession) and closely related accessions (as a result of including approximately 35,000 breeders' lines within the collection). There are relatively few landraces and farmer varieties. Approximately 5,000 accessions are of wild relatives, mostly originating from USDA. The collection also includes approximately 440 accessions of rye (mainly *Secale cereale*) and 16,000 accessions of triticale (*Triticosecale*)

CIMMYT wheat	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**127,689**	**134,979**
Annual recurring cost per accession	**3.28**	**3.28**
Total annual recurring cost of maintaining existing accessions	418,863	442,777
Annual cost of acquiring 1% additional accessions (non-compounded)	34,805	34,805
Total annual capital costs	79,355	79,355
Total Annual Cost	**533,023**	**556,937**

3.5 CIP

3.5.1 Andean Roots and Tubers

The collection comprises approximately 1,800 accessions of 11 species mostly held *in vitro* culture. The most important are oca (*Oxalis tuberosa;* 788 accessions), olluco (*Ullucus tuberosus;* 573 accessions), and mashua (*Tropaeolum tuberosum;* 150 accessions). The majority of accessions are also maintained in the field. Only maca (*Lepidium meyenii)*, and yam bean (*Pachyrhizus* spp.) can be maintained as seed. There are no robust cryopreservation protocols, although some work is being done on oca.

As these crops are not listed in Annex 1 of the International Treaty on PGRFA, their distribution from Peru is very difficult. Thus most distribution of the collection is only within Peru.

CIP Andean Roots & Tubers	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**1,174**	**1,264**
Annual recurring cost per accession	**146.50**	**146.50**
Total annual recurring cost of maintaining existing accessions	171,987	185,171
Annual cost of acquiring 1% additional accessions (non-compounded)	9,179	9,179
Total annual capital costs	16,289	16,289
Total Annual Cost	**197,455**	**210,639**

3.5.2 Potato

The potato collection comprises approximately 7,100 unique accessions, of which about 4,600 are cultivated potato accessions (the majority being Andean native landraces), and the rest (approx. 2,500) are accessions of wild species. The collection includes about 100 improved varieties, mostly from USA. About 14,000 accessions are conserved as seed in long-term storage. This collection includes duplicates that continue to be eliminated from the *in vitro* collection.

Current conservation activities include maintaining materials in the field and *in vitro*, cryopreservation of clonal materials and conservation of true seed. CIP also maintains a DNA collection for research purposes. It should be possible to rationalize some of these activities over time, especially as more accessions are moved into cryopreservation and/or seed. The costs of cryobanking are included as a one-off cost in Section 4.

Germplasm health issues are very critical but are expensive to monitor and control. Around half of the collection requires testing or cleaning but this has not been costed. ISO certification is an important part of the overall approach to plant health/quarantine management by CIP. The cost of maintaining ISO accreditation, approximately $88,000 per year, has not been included in this costing study.

CIP Potato	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**7,213**	**8,188**
Annual recurring cost per accession	**171.49**	**171.49**
Total annual recurring cost of maintaining existing accessions	1,236,951	1,404,153
Annual cost of acquiring 1% additional accessions (non-compounded)	86,319	86,319
Total annual capital costs	149,284	149,284
Total Annual Cost	**1,472,554**	**1639,756**

3.5.3 Sweetpotato

CIP's sweetpotato collection comprises about 8,100 unique accessions. Of the accessions of known origin, about 4,400 are from Latin America (60% from Peru), about 1,300 from Asia/Pacific, 1,000 from Africa and 200 from USA. There are about 1,300 accessions of wild relatives. Efforts are underway to eliminate duplicates and it is estimated that the collection may be rationalized to a target figure of 5,000 unique accessions.

About 5,500 accessions are currently held *in vitro* and 3,000 in the field. As with potato, more than half require health testing or cleaning. Cryopreservation is still not a routine operation, as the protocol needs refining. Once a robust protocol is available (likely within the next five years) it should be possible for cryobanking to become routine. The costs of cryobanking are included as a one-off cost in Section 4. Conserving the collection as seed is made difficult/expensive because very few seeds are produced per clone due to daylength sensitivity and other problems.

CIP Sweetpotato	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**8,108**	**8,979**
Annual recurring cost per accession	**151.75**	**151.75**
Total annual recurring cost of maintaining existing accessions	1,230,355	1,362,525
Annual cost of acquiring 1% additional accessions (non-compounded)	159,630	159,630
Total annual capital costs	107,896	107,896
Total Annual Cost	**1,497,881**	**1,630,051**

3.6 ICARDA

The costs of the *Rhizobium* collection maintained by ICARDA have not been included in this study.

3.6.1 Barley

The ICARDA barley collection comprises approximately 27,000 accessions of which about 2,000 (7%) are wild relatives. The cost per accession of conserving wild barley species is comparable to that of the cultivated species. The collection has a high percentage of landraces and farmer varieties.

ICARDA Barley	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**26,856**	**29,239**
Annual recurring cost per accession	**5.65**	**5.65**
Total annual recurring cost of maintaining existing accessions	151,685	165,144
Annual cost of acquiring 1% additional accessions (non-compounded)	16,362	16,362
Total annual capital costs	43,295	43,295
Total Annual Cost	**211,342**	**224,801**

3.6.2 Chickpea

The collection comprises approximately 13,500 accessions of which about 300 (2%) are wild relatives. The number of wild accessions is not expected to grow substantially as only very few species will cross with the cultivated species, and they are very rare. The collection is primarily of Kabuli (large, beige-seeded) types. There is considerable overlap with the ICRISAT chickpea collection, but collections are maintained in both countries due to quarantine restrictions that increase the difficulty of exchanging germplasm between Syria and India.

ICARDA Chickpea	Annual cost (2010 US$)

Costs	Current	2015
Number of accessions	**13,462**	**14,257**
Annual recurring cost per accession	**6.09**	**6.09**
Total annual recurring cost of maintaining existing accessions	81,953	86,793
Annual cost of acquiring 1% additional accessions (non-compounded)	10,681	10,681
Total annual capital costs	35,358	35,358
Total Annual Cost	**127,992**	**132,832**

3.6.3 Faba Bean

The collection comprises over 9,000 accessions of *Vicia faba*. The collection is monospecific as there are no wild relatives within the primary or secondary genepool. ICARDA maintains a large collection of other *Vicia* species but these will not cross with *V. faba* and are maintained separately as a component of the overall forage and range species collection (see below).

ICARDA Faba bean	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**9,181**	**9,968**
Annual recurring cost per accession	**6.09**	**6.09**
Total annual recurring cost of maintaining existing accessions	55,892	60,683
Annual cost of acquiring 1% additional accessions (non-compounded)	6,180	6,180
Total annual capital costs	49,811	49,811
Total Annual Cost	**111,883**	**116,674**

3.6.4 Forage and Range Plants

The forage and range species collection includes approximately 1,000 species and includes major collections of *Medicago* (8,400 accessions), *Vicia* (6,100 accessions), *Trifolium* (4,500 accessions) and other forage and range genera (5,600 accessions). *Lathyrus* and *Pisum* species have been considered separately (see below) for the purpose of this costing study as both have significant use as a food legume for direct human consumption in addition to their role as forages. ICARDA states a strong requirement for additional professional help with managing this collection (see Section 4).

ICARDA Forage and range plants	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**24,606**	**24,606**
Annual recurring cost per accession	**6.72**	**6.72**
Total annual recurring cost of maintaining existing accessions	165,248	165,248
Annual cost of acquiring 1% additional accessions (non-compounded)	0	0
Total annual capital costs	82,921	82,921
Total Annual Cost	**248,169**	**248,169**

3.6.5 Grasspea

The ICARDA collection of *Lathyrus* comprises 3,200 accessions of a number of different *Lathyrus* species. The largest group is *Lathyrus sativus*, grasspea, which is widely used as a human food by the poorest people in South Asia and Ethiopia. *Lathyrus* is important both as a human food and as an animal feed or forage.

ICARDA Grasspea	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**3,210**	**4,375**
Annual recurring cost per accession	**6.03**	**6.03**
Total annual recurring cost of maintaining existing accessions	19,347	26,368
Annual cost of acquiring 1% additional accessions (non-compounded)	1,872	1,872
Total annual capital costs	11,815	11,815
Total Annual Cost	**33,034**	**40,055**

3.6.6 Lentil

The ICARDA lentil collection comprises 11,000 accessions of which about 10,400 are of the cultivated species and approximately 400 (3.6%) are related wild species.

ICARDA Lentil	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**11,008**	**11,823**
Annual recurring cost per accession	**6.09**	**6.09**
Total annual recurring cost of maintaining existing accessions	67,014	71,976
Annual cost of acquiring 1% additional accessions (non-compounded)	6,986	6,986
Total annual capital costs	22,975	22,975
Total Annual Cost	**96,975**	**101,937**

3.6.7 Pea

The ICARDA pea collection contains materials for use as forage and for human consumption, as a vegetable or pulse. The collection comprises approximately 6,100 accessions.

ICARDA Pea	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**6,075**	**6,380**
Annual recurring cost per accession	**6.03**	**6.03**
Total annual recurring cost of maintaining existing accessions	36,614	38,452
Annual cost of acquiring 1% additional accessions (non-compounded)	4,688	4,688
Total annual capital costs	18,504	18,504
Total Annual Cost	**59,806**	**61,644**

3.6.8 Wheat

The ICARDA wheat collection comprises approximately 40,000 accessions of which about 75% are landraces and farmer varieties. There are approximately 4,000 *Aegilops* spp., 600 *Triticum* spp. and 800 ‘primitive wheats’. Fifty-two percent of the collection, especially materials originating from other major collections such as those of USDA and VIR, is held in both ICARDA and CIMMYT.

ICARDA Wheat	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**39,762**	**41,747**
Annual recurring cost per accession	**7.14**	**7.14**
Total annual recurring cost of maintaining existing accessions	283,703	297,866
Annual cost of acquiring 1% additional accessions (non-compounded)	24,303	24,303
Total annual capital costs	77,213	77,213
Total Annual Cost	**385,219**	**399,382**

3.7 ICRISAT

The main ICRISAT germplasm collections are maintained at the headquarters in Patancheru near Hyderabad, India. However, due to the difficulties of exchanging material between Africa and India, ICRISAT also maintains sizeable collections of material at its three stations in Africa: Niamey (Niger), Nairobi (Kenya) and Bulawayo (Zimbabwe). This is mainly material of African origin or that is particularly important in developing varieties for African conditions. Currently about 15,000 of the accessions maintained in Africa have not yet been duplicated in India. It is more costly to maintain material in Africa compared to India for all crops except groundnut.

ICRISAT divides its crops into three groups for management purposes: chickpea and groundnut (self-pollinated food legumes); sorghum and small millets (self-pollinated cereals): and pearl millet and pigeonpea (crops with high levels of out-crossing). The *Rhizobium* collection has not been costed in this study.

3.7.1 Chickpea

The ICRISAT chickpea collection comprises more than 20,000 accessions of which less than 1% is wild *Cicer* species. There is a considerable level of overlap with the ICARDA collection but very little of the collection is maintained in Sub-Saharan Africa as the crop is only of any importance in Ethiopia.

ICRISAT- Chickpea	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**20,267**	**21,282**
Annual recurring cost per accession	**10.74**	**10.74**
Total annual recurring cost of maintaining existing accessions	217,743	228,648
Annual cost of acquiring 1% additional accessions (non-compounded)	21,446	21,446
Total annual capital costs	30,815	30,815
Annual cost of maintaining 100 accessions in one African regional genebank	22,350	22,350
Total Annual Cost	**292,354**	**303,259**

3.7.2 Groundnut

The ICRISAT groundnut collection comprises about 15,500 accessions of which almost 3% are of wild *Arachis* species. These accessions are three times more expensive to maintain than cultivated accessions. The collection is not growing significantly, largely because groundnut is not included in Annex 1 of the International Treaty on PGRFA.

ICRISAT- Groundnut	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**15,455**	**16,215**
Annual recurring cost per accession	**12.74**	**12.74**
Total annual recurring cost of maintaining existing accessions	196,838	206,651
Annual cost of acquiring 1% additional accessions (non-compounded)	18,630	18,630
Total annual capital costs	26,939	26,939
Annual cost of maintaining 14,020 accessions in one African regional genebanks	180,200	180,200
Total Annual Cost	**422,607**	**432,420**

3.7.3 Pearl Millet

The pearl millet collection comprises approximately 22,200 accessions of which about 3.5% are wild *Pennisetum* accessions. Because of its out-crossing nature, special measures are needed to ensure the genetic integrity of the accessions is maintained.

ICRISAT- Pearl millet	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**22,211**	**23,511**
Annual recurring cost per accession	**12.49**	**12.49**
Total annual recurring cost of maintaining existing accessions	277,332	293,564
Annual cost of acquiring 1% additional accessions (non-compounded)	35,107	35,107
Total annual capital costs	28,811	28,811
Annual cost of maintaining 11,389 accessions in three African regional genebanks	199,320	199,320
Total Annual Cost	**540,570**	**556,802**

3.7.4 Pigeonpea

The pigeonpea collection comprises about 13,600 accessions of which about 4% are wild related species of *Cajanus* and *Rhynchosia.* Because of high levels of out-crossing, special measures are needed to avoid crossing among accessions.

ICRISAT- Pigeon pea	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**13,632**	**14,312**
Annual recurring cost per accession	**12.86**	**12.86**
Total annual recurring cost of maintaining existing accessions	175,356	184,103
Annual cost of acquiring 1% additional accessions (non-compounded)	22,277	22,277
Total annual capital costs	17,688	17,688
Annual cost of maintaining 1,000 accessions in one African regional genebanks	29,900	29,900
Total Annual Cost	**245,221**	**253,968**

3.7.5 Small Millets

The ICRISAT small millet collection comprises about 10,200 accessions of 6 millets: barnyard millet (*Echinochloa colona frumentacea*, approximately 800 accessions), finger millet (*Eleusine coracana coracana*, approximately 6,000 accessions), foxtail millet (*Setaria italica* approximately 1,600 accessions), kodo millet (*Paspalum scrobiculatum*, approximately 700 accessions), little millet (*Panicum sumatrense,* approximately 500 accessions), and proso, millet (*Panicum miliaceum*, approximately 900 accessions).

ICRISAT- Small millets	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**10,235**	**11,623**
Annual recurring cost per accession	**15.75**	**15.75**
Total annual recurring cost of maintaining existing accessions	161,182	183,040
Annual cost of acquiring 1% additional accessions (non-compounded)	20,346	20,346
Total annual capital costs	12,164	12,164
Annual cost of maintaining 1,500 accessions in one African regional genebanks	34,300	34,300
Total Annual Cost	**227,992**	**249,850**

3.7.6 Sorghum

The sorghum collection is the largest of the ICRISAT germplasm collections at approximately 38,000 accessions. Wild species account for about 3% of this total but are expected to rise to approximately 5% and are, on average, about two and one-half times more expensive per accession to maintain than cultivated sorghum.

ICRISAT- Sorghum	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**37,949**	**42,003**
Annual recurring cost per accession	**10.20**	**10.20**
Total annual recurring cost of maintaining existing accessions	387,122	428,478
Annual cost of acquiring 1% additional accessions (non-compounded)	47,484	47,484
Total annual capital costs	48,547	48,547
Annual cost of maintaining 8,565 accessions in three African regional genebanks	204,200	204,200
Total Annual Cost	**687,353**	**728,709**

3.8 IITA

3.8.1 Banana and Plantain

The IITA banana and plantain collection comprises 290 accessions. The collection was not included in the agreement signed with the International Treaty. The collection is maintained as living plants in the field with 173 also maintained *in vitro*. There used to be a collection at the IITA Onne Station near Port Harcourt, Nigeria, but due to security concerns it has largely been abandoned. However, there is little information about that collection, whether it is still there or can be rehabilitated, and even the extent to which it has been duplicated at the Bioversity ITC in Leuven. If it still exists and can be rescued, there will be considerable costs associated with doing so and moving it to Ibadan. Overall no new material is coming into the collection and it is not expected to expand significantly in the future unless material can be recovered from Onne.

IITA Banana	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**290**	**290**
Annual recurring cost per accession	**66.24**	**66.24**
Total annual recurring cost of maintaining existing accessions	19,209	19,209
Annual cost of acquiring 1% additional accessions (non-compounded)	0	0
Total annual capital costs	9,317	9,317
Total Annual Cost	**28,526**	**28,526**

3.8.2 Cassava

The cassava collection comprises approximately 2,800 accessions, the large majority of which are of African origin. There is essentially no overlap with the CIAT collection. The collection is maintained both in the field and *in vitro*, with approximately one-third of the collection being sent annually as *in vitro* samples to Cotonou for safety duplication. The production of botanical seed is being investigated as a conservation option. A cryotank is being purchased for the conservation of cryopreserved accessions and a protocol is being refined. Cryobanking is likely to start within the next few years.

IITA Cassava	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**2,783**	**2,923**
Annual recurring cost per accession	**70.00**	**70.00**
Total annual recurring cost of maintaining existing accessions	194,817	204,618
Annual cost of acquiring 1% additional accessions (non-compounded)	7,516	7,516
Total annual capital costs	62,331	62,331
Total Annual Cost	**264,664**	**274,465**

3.8.3 Cowpea

The cowpea collection comprises approximately 16,600 accessions, of which 1,650 are wild *Vigna* species. The large majority of the accessions of both cowpea and wild *Vigna* are of African origin. Seed-borne diseases are a problem and the large majority of the collection requires cleaning. The costs for this are included in Section 4.

IITA Cowpea	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**16,629**	**17,747**
Annual recurring cost per accession	**11.15**	**11.15**
Total annual recurring cost of maintaining existing accessions	185,359	197,821
Annual cost of acquiring 1% additional accessions (non-compounded)	20,072	20,072
Total annual capital costs	223,578	223,578
Total Annual Cost	**429,009**	**441,471**

3.8.4 Maize

The IITA maize collection currently comprises about 900 accessions, almost entirely of West African origin. The collection is not designated under agreement with the International Treaty. It is aimed to develop this as a comprehensive West African maize collection with an eventual size of about 1,600 accessions. Approximately 500 accessions are included in the CIMMYT collection and it is planned to include the rest at CIMMYT over the coming year or two. The costs for this are included in Section 4.

IITA Maize	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**878**	**1,118**
Annual recurring cost per accession	**12.12**	**12.12**
Total annual recurring cost of maintaining existing accessions	10,638	13,546
Annual cost of acquiring 1% additional accessions (non-compounded)	1,545	1,545
Total annual capital costs	16,301	16,301
Total Annual Cost	**28,484**	**31,392**

3.8.5 Miscellaneous Food Legumes

IITA maintains small collections of a number of food legume species that together comprise about 4,350 accessions. The largest collections are of bambara groundnut (*Vigna subterranea*, 1,843 accessions) and soybean (*Glycine max*, 1,751 accessions). Other legumes in the collection include African yam bean, green gram, Jack bean, Kersting's groundnut, lablab bean, lima bean, mucuna bean, mung bean, pigeonpea, sword bean and winged bean. Because of the small size of these collections and the similar per-accession costs of conserving them, they have been treated as a single collection in this costing study.

IITA Miscellaneous legumes	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**4,346**	**4,612**
Annual recurring cost per accession	**11.78**	**11.78**
Total annual recurring cost of maintaining existing accessions	51,184	54,316
Annual cost of acquiring 1% additional accessions (non-compounded)	4,002	4,002
Total annual capital costs	47,488	47,488
Total Annual Cost	**102,674**	**105,806**

3.8.6 Yam

The IITA yam collection comprises about 3,360 accessions of 8 different *Dioscorea* yam species. Of these, more than two-thirds are *D. rotundata* and a further 770 of *D. alata*. Around a third of the collection has been introduced into i*n vitro* culture. Further research is urgently needed to improve the protocols for *in vitro* conservation, as well as disease diagnostics and cryopreservation in order to be able to optimize the structure of the collection and develop a more routine state of maintenance. The costs of conservation methods research are not specifically included in this study. However, the costs of introducing accessions from the field collection into *in vitro* is costed as an annualized cost.

IITA Yam	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**3,360**	**4,724**
Annual recurring cost per accession	**63.93**	**63.93**
Total annual recurring cost of maintaining existing accessions	214,797	301,995
Annual cost of acquiring 1% additional accessions (non-compounded)	11,436	11,436
Total annual capital costs	28,862	28,862
Total Annual Cost	**255,095**	**342,293**

3.9 ILRI

3.9.1 Tropical Forages

The ILRI forage collection is made up of about 18,290 accessions of more than 1,000 species. It comprises approximately 1,100 annual grasses, 4,900 perennial grasses, 4,900 annual legumes, 8,000 perennial legumes, 900 trees and shrubs and approximately 3,500 accessions of annual species of other genera. Approximately 45% of the collection is of African origin, 30% is from highland Latin America and the origin of the remaining 25% of the accessions is unknown. Only about 2,200 accessions are currently maintained in long-term storage and approximately 1,400 accessions (mainly trees, shrubs and some herbaceous perennials) are maintained in a field gene bank.

ILRI Tropical forages	Annual cost (2010 US$)	
Costs	**Current**	**2015**
Number of accessions	**18,921**	**18,921**
Annual recurring cost per accession	**32.95**	**32.95**
Total annual recurring cost of maintaining existing accessions	623,449	623,449
Annual cost of acquiring 1% additional accessions (non-compounded)	0	0
Total annual capital costs	200,828	200,828
Total Annual Cost	**824,277**	**824,277**

3.10 IRRI

3.10.1 Rice

The IRRI rice collection comprises about 110,800 accessions of which about 4,600 are wild relatives and hybrids. The large majority of the collection is of Asian rice (*Oryza sativa*) but it also includes about 1,650 accessions of African rice (*O. glaberrima*). The number of wild accessions is expected to increase, but the cost of maintaining them is high (approximately three times the cost of maintaining an accession of cultivated rice) in large measure because of the need to grow them out in containment facilities (screenhouses) to ensure there are no escapes.

The following Table combines data for both cultivated and wild rice (N.B. these are shown separately in Annex 5).

IRRI – cultivated rice	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**106,319**	**115,899**
Annual recurring cost per accession	**7.36**	**7.36**
Total annual recurring cost of maintaining existing accessions	782,571	853,017
Annual cost of acquiring 1% additional accessions (non-compounded)	123,566	123,566
Total annual capital costs	205,485	205,485
Total Annual Cost	**1,111,622**	**1,182,068**

IRRI – wild rice	**Annual cost (2010 US$)**	
Costs	**Current**	**2015**
Number of accessions	**4,498**	**4,723**
Annual recurring cost per accession	**21.27**	**21.27**
Total annual recurring cost of maintaining existing accessions	95,672	100,458
Annual cost of acquiring 1% additional accessions (non-compounded)	19,997	19,997
Total annual capital costs	139,008	139,008
Total Annual Cost	**254,677**	**259,463**

4. One-time (one-off) and other costs

The following tables (4.1 and 4.2) indicate the major total one-time costs that are foreseen and for which funding will be required over the next 1 - 5 years, depending on the activity concerned. Some activities have a longer time-frame and will require further funding beyond the 5-year time frame of this report. As these are one-time costs, and should not recur once completed, they have not been included in the summary tables in Section 3 that show annualized costs.

Table 4.1 lists the costs of ‘optimizing’ the collections, e.g.:

- bringing seed collections into long-term storage where this is still needed
- bringing *in vitro* collections into cryopreservation where this is feasible and
- health testing and sanitation

Table 4.2 gives the one-time cost of acquisition of material from the Regeneration Project that is over and above the annual ‘background’ acquisition rate of 1% of the 2010 total (already accounted for in the annualized costings above).

In addition to these one-time costs, the ICARDA genebank manager made a strong case for an additional international scientist to manage their extensive and highly diverse collection of forage and range plants. While this was outside the terms of reference of this study and has therefore not been included in the costing presented here, the consultants were particularly sympathetic to this request and hope that a solution to this can be found. Such recruitment would, of course, increase the annual costs presented for ICARDA.

Table 4.1 One-time cost for optimizing the collection

Centre	Activity	Total Cost (US$)
Africa Rice	Processing 8000 accessions from medium-term storage into long-term storage	494,339
Bioversity	Cryobanking and safety duplicating 464 accessions (this activity is dependent on infected samples being cleaned and thus may include an additional cost for cleaning)	728,944
CIAT	Regenerating for long-term storage and safety duplicating 16,191 bean accessions	2,528,428
	Cryobanking 1000 cassava accessions	292,000
	Regenerating for long-term storage and safety duplicating 9,250 forage accessions	3,086,965
CIP	Cryobanking 750 potato accessions	445,313
	Health testing and cleaning materials in the *in vitro* collection	264,033
	Cryobanking 750 sweetpotato accessions	1,154,385
	Health testing and cleaning materials in the *in vitro* collection	500,864
IITA	Health-testing 13,303 cowpea accessions	687,504
	Safety duplicating and characterisation of 300 maize accessions	48,122
ILRI	Processing 4,000 forage accessions into long-term storage	1,170,158
		Total: 11,401,055

Table 4.2 One-time costs for introducing accessions from Regeneration Project

	Centre	Activity	Total Cost (US$)
1	CIAT	Bean introductions	267,704
		Cassava introductions	86,940
2	CIMMYT	Maize introductions	2,344,977
		Wheat introductions	24,200
3	CIP	Potato introductions	737,311
		Sweetpotato introductions	918,367
4	ICARDA	Barley introductions	63,679
		Faba bean introductions	21,965
		Grasspea	58,784
		Lentil introductions	19,817
5	ICRISAT	Pearl millet introductions	30,047
		Small millets introductions	175,135
		Sorghum introductions	270,496
6	IITA	Bambara groundnut introductions	24,755
		Cowpea introductions	34,824
		Maize introductions	33,478
		Yam introductions	401,592
7	IRRI	Rice introductions	469,620
			Total: US$ 5,983,691

5. Some general observations and conclusions

Wild Relatives.
Species that are taxonomically related to the domesticated crops maintained by the Centres are becoming increasingly important as a source of genes for crop improvement. New techniques for inter-specific hybridization, the identification of desirable alleles and for the direct transfer of genes are all making crop wild relatives ever more important. While crop wild relatives currently only account for about 5% on average of the CGIAR collections, a proportion that varies considerably from collection to collection, in most cases this number is likely to expand considerably over the coming years. While for some crops the management of wild relatives involves a similar process and costs to those for maintaining accessions of cultivated forms, in other cases the costs are substantially higher due to factors such as the difficulty of creating the right environmental conditions, perenniality, seed dormancy, low seed multiplication rates, the need to prevent escape, etc. For many collections, the expanding numbers of wild relatives could result in substantially increased costs over time. Given the current low proportion of wild relatives, no special attention has been given to costing wild relatives in this study and they have just been included within the total collection numbers. However, it might be worth conducting a separate study in the future to look at the additional costs involved.

Clonal crops
Vegetatively-propagated crops in Centre collections include the Andean root and tubers, banana, cassava, potato, sweetpotato and yam. In all cases the primary collections are held *in vitro*, where possible under slow-growth conditions, or in the field. The conservation methods and processes used are still in the process of being optimised, research remains an important component of annual costs and the structure of collections is generally not the most cost-effective for the long-term. An “ideal” conservation system for most of the clonal crops in the CGIAR genebanks might be to cryopreserve the whole collection (with a duplicate cryopreserved set held in another country), with only those accessions that are regularly required for distribution being maintained *in vitro*, and/or in the field. A further back-up of true seed, where this is possible, would be worthwhile and the use of lyophilized leaf tissue, or extracted DNA also has a role to play in certain circumstances. Given the labour intensive methods needed for conserving such crops, it is not surprising that the costs per accession are considerably higher than for seed crops and a number of efforts are underway in several of the Centres to reduce overall costs and increase security. Furthermore, vegetative materials are generally subject to considerably more diseases (especially viruses) of quarantine importance than are seed crops, and these are often very expensive to index and treat (see next section).

Germplasm health. Diseases and insects pose a major problem for genebank managers who must identify and eliminate infectious diseases, seed-borne diseases and insects that infest the seeds. Post harvest inspections are essential to ensure that the samples are free from disease and thus have greater longevity in storage. Degradation of seed as a result of various fungal and bacterial infections will, over time, reduce germination and affect the genetic integrity of the sample. Disease and insect inspection and control are also vital for enabling samples to be distributed internationally. Costs vary considerably by Centre and crop, and viruses are perhaps the most common and troublesome culprits. As noted above, the vegetatively-propagated crops generally bear more viruses than seed crops and quarantine restrictions are generally more severe. The cost of virus indexing and therapy are both very high and whereas disease-free tissue cultures provide a vehicle for distribution and quarantine clearance, the costs can be very high.

Regeneration interval. Seed regeneration is one of the most significant factors affecting the overall cost of maintaining an accession. Lengthening the interval between regenerations can significantly reduce this cost. The frequency of regeneration is dependent upon two factors: seed quality and seed quantity. Seed quality is affected by a number of factors including the presence of diseases and insects in the sample (see above) as well as inherent viability as a result of harvesting and seed handling procedures. The management of the seed from the time of seed maturity on the plant to the time it is placed in a cold room can have a major impact on seed quality.

If regeneration intervals are to be lengthened genebank managers also need to produce more seed of the most popular accessions to gain field and processing efficiencies. Often a new accession or an old accession with newly identified special properties has high demand for several years and then the demand tails off. Significant cost savings at genebanks can be achieved by good inventory control.

Role of genebanks. Genebanks play many roles. As suppliers of genetic resources to breeders around the world they are perhaps one of the Centres' most visible interfaces. While the Centres have generally had very positive publicity at international fora such as the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture, it is important that the genebanks deliver requested germplasm in a timely manner and of superior quality. Failure to do so will reflect badly upon their operation and ultimately their funding. As the interface of their Centres in numerous meetings, genebank managers need to be especially alert to the issues that others face in germplasm management and distribution.

The Centres play a particularly important role in providing international leadership and coordination – a role that in many cases can, and should, be enhanced. They are also important providers of training and information to national and other genebanks.

At the Centre itself, the genebanks supply Centre programs with the necessary germplasm to conduct their research. The interface between the genebank managers and the breeders, physiologists, plant pathologists and others is particularly important – and in an ideal situation there should be a very synergistic relationship with each building on and contributing to the work of the others. As curators of the germplasm in perpetuity for humanity they bear a large responsibility to ensure that it is maintained in the most effective, efficient and healthy way.

Future studies: In spite of the limitations of the study mentioned in the report, the consultants believe the results presented here are an important step forward in understanding the real costs of maintaining and distributing the Centres' germplasm collections and of making available the associated information. However, it should be noted that what is provided is only a snapshot of costs at this particular point in time. The situation is not static and will continue to evolve. For example, most of the collections are expected to continue to increase in size – although it might be possible to reduce the size of some by eliminating duplicates. The collections are also expected to acquire proportionally more accessions of wild relatives, and these are generally more difficult and expensive to maintain than cultivated accessions. In addition it might be possible to reduce the cost of conserving clonal collections through a greater use of cryopreservation, true seed and other technologies but this is likely to require a considerable up-front expenditure before any cost savings can accrue. While the costs of molecular characterization are expected to fall, the need for more virus, and other disease indexing and cleaning might well increase. For these and many other reasons, it will be important that the Consortium, Trust and genebank managers continue to monitor costs over the coming years.

ANNEX 1: Terms of Reference

Joint Ex Situ Conservation Costing Study
by
the Consortium of International Agricultural Research Centres
and
the Global Crop Diversity Trust

Draft Terms of Reference

Background

A study is to be jointly commissioned by the Consortium of International Agricultural Research Centres and the Global Crop Diversity Trust to determine, in a standardized, uniform way, the costs of conserving the important international plant germplasm collections that are maintained ex situ by the Centres of the Consortium. The need and rationale for the joint study is described in the Memorandum of Understanding between the two parties, signed in July 2010. This MoU states that:

> *"The Trust and the Consortium will jointly agree on the Terms of Reference for the assessment study and find the funds to conduct it, jointly announce its initiation, and confer closely on the analysis, final text and any recommendations of the study with the aim to produce a jointly agreed document."*

This document sets out the Terms of Reference for the joint study.

General Terms of Reference

A study is being jointly commissioned by the Consortium and the Trust to determine the costs of managing the Centres' germplasm collections to international standards, and of making them and the information about them available under the terms of the International Treaty on Plant Genetic Resources for Food and Agriculture.

The two parties, following consultation with the Centres regarding the final text of the document, will publish the results of the joint study in a publicly available document.

Specific Terms of Reference

In order to meet these general Terms of Reference, and recognizing that the joint study will be multifaceted and complex, it will be important that there be some flexibility for the specific Terms of Reference, described below, to be amended during the course of the study, as needed and as mutually agreed by the parties to the MoU.

This study will, naturally, draw lessons from and improve upon previous attempts at costing the maintenance of genebanks in the CGIAR, such as GPG2.

Many areas to be considered in the joint study will require establishing boundaries on what to include, or exclude from the study (crops, specific activities etc.); agreeing standards, norms and targets (e.g. regarding safety duplication, person hours required for a particular task, the extent of molecular characterization to be covered, etc); and making assumptions (e.g. on how fast a collection is likely to grow, or when a particular cryopreservation protocol might become available). Guidance on some of these ‘grey’ areas is given in the specific terms of reference below.

However, there will still be a need for those carrying out the study to make pragmatic decisions on a number of issues, drawing on their own individual expertise and experience. All such decisions should be fully documented,

1) The joint study will assess the costs of maintaining the internationally important germplasm collections by the Centres. More specifically, the study will focus on the following collections[9]:

- Bioversity International: banana and plantain
- CIAT: bean, cassava, tropical forages
- CIP: potato, sweetpotato, Andean root and tuber crops
- CIMMYT; maize and wheat (Triticale, barley, rye)
- ICARDA: barley, chickpea, faba bean, forages (including *Lathyrus* and *Pisum*), lentil, wheat
- ICRISAT: chickpea, groundnut, sorghum, millet (pearl and minor millets), pigeonpea
- IITA: cassava, cowpea, Musa, soya bean, yams, yam bean, maize
- ILRI; forages
- IRRI: rice
- AfricaRice: rice

While it is recognized that Centres also maintain other collections (e.g. tropical legume species at IITA) these will not be included in the joint study unless this is mutually agreed upon during the course of the study in consultation with the Centre concerned. Likewise only ‘traditional’ collections of cultivated and wild germplasm will be included and specialized collections (e.g. mapping populations, Rhizobium collections etc.) will not be covered except where these are judged by the consultants to be an important element in the overall long-term conservation of a particular genepool. A decision on this will be made on a case-by-case basis.

2) The study will assess recent and current actual costs of managing the existing collections. The study will aim to provide information on costs on a standardized basis that will allow direct comparison across collections of the same crop held by different Centres (e.g. rice at IRRI, CIAT and WARDA) and, to the extent possible, for generalized conservation costs to be compared across Centres.

3) The joint study will not include in this assessment the costs of collecting new material from the field. However, in making projections of future funding needs, an estimate will be made of likely expansion (or possibly contraction[10]) in the size of the collection over the coming 10 years, based on the assumption that the overall structure of the collections will not change

[9] The nature of the collections maintained by ICRAF may be considered in a second, follow-up study that would also look in greater detail at the costs of conserving crop wild relatives.

[10] For example as a result of global rationalization of collections and / or the elimination of unnecessary replicates within a collection.

significantly. No special provision should be made, for example, for the possibility that collections might evolve in the future to include a significantly higher proportion of crop wild relatives[11] or that a greater use might be made of core collections.

4) The study will include the costs of all key aspects of conservation including:
- entering materials into storage,
- storage itself,
- viability testing and regeneration,
- characterization (including a minimum molecular characterization to be determined on a crop-by-crop basis),
- safety duplication (in a different genebank and at the Svalbard Global Seed Vault where appropriate),
- managing information and making it available publicly through a portal such as Genesis, and distributing the material safely to *bona fide* users.

Costs of evaluation for quantitative traits, pre-breeding and breeding will not be included. Costs associated with training genebank staff (internal and external) and of leading or participating in regional and global genetic resources activities outside the CGIAR (e.g. in the creation and operation of global crop databases or distributed virtual global collections) will likewise not be included in this study.

5) While the study will, to the extent possible, apply uniform conservation standards across all crops, some differences among species will be inevitable. The decision on the conservation standards to be applied will be made on a crop-by-crop basis by those responsible for conducting the study, following consultation with the holders of collections of the crop concerned.

6) The costs of cryoconserving those collections for which this is currently a viable long-term conservation option (or for which adequate protocols are expected to become available within the next 5 years) should be assessed.

7) Overhead costs should be calculated and included in accordance with CGIAR norms.

[11] A separate study may be needed in the future to look at costing the conservation of crop wild relatives, as these are likely to significantly expand in importance and are generally more difficult and costly to conserve that cultivated germplasm.

ANNEX 2: The Consultants

Henry Shands, a US citizen, is a world-renowned leader in the conservation of plant genetic resources and has extensive practical experience in genebank management. His accomplishments include his leadership in developing the USDA's genetic resources system into an internationally recognized, coherent, and accountable system of germplasm sites within the USA. He retired as Director of the USDA-Agricultural Research Service’s National Center for Genetic Resources Preservation in 2007. He was the ARS's Assistant Administrator for Genetic Resources in Washington, D.C. from 1997 to 2000 and is a Past President of the Crop Science Society of America (CSSA). Dr Shands has been active internationally and has had considerable contact with the CGIAR. For example, he advised the CGIAR’s System-wide Genetic Resources Programme (SGRP) on the allocation to the Centres of the funds provided by the Global Public Goods programmes (GPG1 and GPG2) of the World Bank. This involved a detailed understanding of the management and costs of operating the CGIAR Centre genebanks. Most recently Dr Shands was the team leader of the final Project Evaluation of GPG2 in April 2010 where he reviewed the achievements and activities of this Project, including the genebank costing tool.

Geoffrey Hawtin, a dual British/Canadian citizen, has also had an extensive career in the conservation and use of plant genetic resources, much of it within the CGIAR. As Leader of the Food Legume Improvement Programme of ICARDA in the 1970s and early 1980s, he played a major role in establishing ICARDA's international collections of chickpea, faba bean, lentil and pea. From 1991 to 2003 he was Director General of Bioversity International (then IPGRI) and during this time he was responsible for establishing and leading the SGRP. He was also Secretary of the CGIAR's Genetic Resources Policy Committee (GRPC) and was the focal point for the CGIAR's involvement in the negotiation of the International Treaty on Plant Genetic Resources for Food and Agriculture. He spearheaded the establishment of the Global Crop Diversity Trust and on leaving Bioversity in 2003 became the Trust's first CEO. In 2008-2009 Dr Hawtin was Director General of CIAT. He currently Chairs the Board of Directors of CATIE in Costa Rica, is a member of the Board of Trustees of Kew Royal Botanical Gardens, UK and has recently joined the Board of Trustees of CIAT.

Gordon MacNeil, a Canadian citizen, is an international civil servant with over 35 years of employment in the international development sector. Starting as an overseas CUSO volunteer in the early 1970's he gained experience in administration and financial management through employment in IDRC, Canada where he had increasingly senior assignments culminating as Deputy Director of the Social Sciences Division. In 1988, Mr. MacNeil joined the CGIAR system as the first Director of Finance and Administration of the WARDA (now AfricaRice) and in late 1992, he moved to the World Bank as senior finance officer in the CGIAR Secretariat. He joined IRRI in 1998, as Treasurer and Director for Finance where, in addition to the Institute management responsibility, he conceptualized and then participated in the creation of the CGIAR Internal Audit Unit (IAU). In 2003, he moved to ISNAR in The Hague, with the assignment of helping to coordinate its legal closure and the program merger/integration with IFPRI. He has since consulted extensively with CGIAR centres and currently is President of the XCG International Consulting Group, Inc. He was a member of the Board of Trustees of CIAT from 2008-2010, and is presently on the Board of Directors of CATIE in Costa Rica.

ANNEX 3. Decision Support Tool

The Decision Support Tool is a excel file created to store genebank cost information and at the same time produce reports that can guide genebank managers or curators to make key management decisions. The tool has been developed based on the framework of Koo *et al.,* 2004. It is a file with a series of entry forms for collecting annual information about the genebank and materials held, operations performed, and input use related to these operations. Based on this information an output report is produced.

General information about the genebank includes details that will affect the overall costs and performance of the genebank such as year of evaluation, materials and number of accessions held, operations performed and, if applicable, the overhead rate charge by the genebank or the hosting center. Critical information needed to estimate current total and average costs are number of accessions per type of genetic material held at the genebank as well as the number of accessions manipulated annually according to each operation performed. The tool includes a set of predefined operations (acquisition, characterization, regeneration, safety duplication, viability testing, seed processing, cryopreservation, in-vitro collection, seed health testing, information management, and general management) but some additional operations can be added if necessary.

Detailed **input use** and related expenses are entered in the decision tool by dividing the information according to the type of input: capital, quasi-fixed, variable labour and variable non-labour. Capital inputs are fixed costs and therefore are not sensitive to size of the operations. Examples of capital inputs are infrastructure such as germplasm storage and genebank facilities and/or equipment for field operations and offices. The information entered for each capital item comprises costs, year of acquisition and service life. Ideally the value entered should be a replacement value however this value often is difficult to obtain. The tool therefore is programmed to bring the value from the year of acquisition to current values, using the consumer price index (CPI). Note that in order to make annual estimations the value of the capital input has to be annualized using a discount factor. The discount factor use is derived from the interest rate at the country where the genebank is located[12].

Variable inputs, on the other hand, are sensitive to size of the operation. Variable inputs include non-labour costs and some labour costs. Non-labour variable costs mainly consist of inputs or supplies consumed on a regular basis such as energy, office and laboratory supplies. Usually these supplies use can be related to the number of accessions manipulated per operation per year. The variable labour cost information corresponds to salaries paid to temporary workers and non-senior staff. This information is available through the financial system in each genebank. Senior scientists and technicians are treated as quasi-fixed labour or inputs. Quasi-fixed inputs are more variable than fixed capital inputs but unlike variable costs, they are not easily apportioned when the size of the operation changes. To give an example, each genebank needs at least a regeneration expert independent of the number of accession multiplied in the field each year. However, if the number of accessions increases dramatically there might be a need to increase the staff.

The **output report** presents total and average costs per input category, genetic material, and type of operation. To estimate the total and average genebank costs the cost of each input is distributed twice, first across materials and then across operations. The distribution across materials is done according to the total number of accessions manipulated each year. The distribution across operations requires entering allocation rates. These allocation rates are elicited base on expert knowledge. The final costs estimations are very sensitive to these allocation rates.

The report also includes a graphic representation of the distribution of total costs. In the current version of the tool, this graph depicts the distribution of costs per input type, but other

[12] . Commonly genebanks or the hosting centers have accounts in US, Europe, or other international banking centres. Therefore the interest rate and CPI used is the one reported for the USA or OECD countries.

graphs could be developed based on expressed needs of genebank managers. The decision tool can be used to investigate how genebank costs and genebank performance are affected by changes in key parameters. Thus the tool serves to directly identify genebank operational costs (e.g. cost of storing, regenerating etc. one accession) and, indirectly to cost drivers (e.g. a factor, which causes a change in the cost of an activity).The framework proposed in the tool allows managers to discern how to improve performance through re-allocating resources, or how to maintain performance levels despite budget constraints.

The long term goal of this cost collection exercise is to evaluate the relationship between performance and costs and support genebank managers in their decision process. The availability of several years of information will probably facilitate this task. The main challenge to achieve this goal is to make the right assumptions about the links among performance indicators, input use and costs. These links might not be as intuitive as expected. The variation in life cycle of the different operations conducted in the genebank, the share of resources allocated by genetic material, activity and/or operation diffuse the effect of input use on performance, making it difficult to isolate and establish causal relationships.

ANNEX 4: Table of what was included in, and excluded from the costing study

Tool Operation	**Tool guidelines**	**What should be included:** (Using activities identified by the ICWG as critical)	**Does not include:** (covered by another operation or considered a one-off activity or activity requiring special funds)

Tool Operation	Tool guidelines	**What should be included:** (Using activities identified by the ICWG as critical)	**Does not include:** (covered by another operation or considered a one-off activity or activity requiring special funds)
Acquisition	This involves the activities related to receiving and processing newly introduced accessions.	Shipping packing Permits and paperwork Most activities under this are covered elsewhere	1. Gap identification 2. Collecting mission 3. Phenotypic characterisation, multiplication, seed processing and safety duplication for initial storage (occurs with these specific activities) 4. Disease-indexing/quarantine for initial storage (occurs with these specific activities) 5. Disease-cleaning for initial storage (occurs with these specific activities)
Characterization	This is the activity of recording the characteristics of each accession, often conducted during the regeneration process.	Data collection, Recording of morphological characteristics Identification *All field and material preparation, planting, etc. is included under "Regeneration", UNLESS characterisation is carried as a separate operation to regeneration.*	1. Identification of duplicates (synonymous grouping with DNA markers, Field planting to confirm with morphological chars, Management of duplicates) 2. Taxonomy/ verification (Maintenance of herbarium collection, Maintenance of seed herbaria collection. Imaging and maintaining images) 3. Molecular characterisation (PCR and other molecular procedures Analysis and formation of core collection and reference sets)
Safety duplication (or security duplication)	This is the activity of sending sample accessions to different locations for safety reasons (i.e., backup collection).	Identification and checking of suitable location Selection of accessions Labelling and packing Processing and preparing certificates, permits LOAs, MTAs Postage/shipping	1. Disease-indexing/quarantine for initial storage 2. Multiplication 3. Data entry and database management 4. Database safety backup
Long-term seed storage	This activity is for the conservation of accessions in the long-term storage facility. Cold room.	Costs of services (electric, cooling equipment, alarm/monitoring system, security and general maintenance) Sample storage Stock management	1.Germination viability testing 2.DNA genebanks 3.Seed processing/preparation 4. Cryopreservation, In-vitro conservation

Tool Operation	Tool guidelines	What should be included: (Using activities identified by the ICWG as critical)	Does not include: (covered by another operation or considered a one-off activity or activity requiring special funds)
Medium-term seed storage	This activity is for the conservation of accessions in the medium-term storage for ready dissemination upon request. Cold room	Costs of services (electric, cooling equipment, alarm/monitoring system, security and general maintenance) Sample storage Stock management	1.Germination viability testing 2.DNA genebanks 3.Seed processing/preparation 4. Cryopreservation, In-vitro conservation
Field genebank		Field management/irrigation Field inspection for diseases Processing for planting (cuttings, tubers, sanitation) Germplasm harvesting (non-perennials)	1.Characterization 2. Any lab activities (e.g. health testing)
Maintenance of the cryopreserved collection		Germplasm maintenance in liquid nitrogen Cryopreserved sample monitoring	1. Costs associated with the introduction of new material into cryopreservation
Introduction of new accessions into cryopreservation		Multiplication and introduction of new material into cryopreservation.	1. Maintaining cryopreserved collection
Maintenance of the *In vitro* collection	In vitro conservation / medium- and long-term storage, sub culturing	In vitro seedling monitoring (viability/vigour check, elimination of old culture, contamination) Germplasm subculturing for conservation Germplasm maintenance using slow-growth methods	1.Disease-cleaning 2. Disease-Indexing 3.Introduction into cryopreservation 3.Multiplication for dissemination
Introduction or multiplication of accession in the in vitro collection		Introduction into cryopreservation Multiplication for dissemination or safety duplication Germplasm processing for in vitro introduction	

Tool Operation	Tool guidelines	What should be included: (Using activities identified by the ICWG as critical)	Does not include: (covered by another operation or considered a one-off activity or activity requiring special funds)
Germination testing (or viability testing)	This is the (periodic) activity of testing germination rate of existing or newly multiplied accessions.	Germination test before storage Viability monitoring during storage.	
Regeneration	This is the activity of getting fresh seeds by planting out seeds for storage or dissemination.	Monitoring/analyzing/planning need for regeneration Seed/planting material preparation. Field preparation Isolation cages for cross-pollinated species. Planting and field management Indexing/sanitation Harvesting of seed/tuber/cuttings for storage. *(Includes regeneration for introduction of new accessions, multiplication for storage and multiplication for distribution, etc)*	1. Characterisation data collection 2. Indexing/sanitation 3. In vitro subculture
Seed processing	This is the activity of packing, cleaning and drying seeds – for storage or distribution	Processing, drying, packing, labelling. Threshing/mechanical cleaning. Seed extraction, washing and cleaning for 'wet' seed. Drying operations. Moisture content testing. Sample sorting	1. Sample identity check, inc. grow-out and DNA testing 2. Germination test before storage 3. Disease diagnostics before storage 4. Viability monitoring during storage 5. Field health inspections 6. In vitro costs of any kind
Seed health testing	This activity involves the testing of seed health, often carried out upon acquisition or during regeneration process.	Disease diagnostics before storage and dissemination	1. Cleaning 2. In vitro costs
Distribution	This involves the activity of sending accessions upon request (e.g., preparation, shipment, etc).	Selection of accessions. Communication with requestor (follow up, question answering, advice). Seed sorting and weighing. Labelling and packing. Phytosanitary requirement follow-up. SMTAs issuance. Shipping/mailing.	1. Multiplication/regeneration of samples 2. Disease-indexing 3. Leaf sample preparation

Tool Operation	Tool guidelines	What should be included: (Using activities identified by the ICWG as critical)	Does not include: (covered by another operation or considered a one-off activity or activity requiring special funds)
Information and data management	This activity includes data entering, processing and management (including catalog preparation).	Management of hard copy documentation/field and lab books/collection sheets/MTAs/agreements. Database management and data backup. Data publication system for external users Data entry and analysis. Data verification. Effective data validation, procedures for data quality assurance. Data transfer to other platforms. Development for communication with information platforms. Online catalogues and ordering system	1. Software applications and web development 2. Barcoding software development
General management	This is the activity that is difficult to allocate to a specific activity (e.g., genebank manager's work).	**Operation of people management, administration, planning, risk management and networking with peers.** *People management* - Staff supervision Mentoring Performance evaluation Planning HR and capacity development needs. *Administration* - Monitoring/analyzing/planning activities Donor reporting and performance indicators Medium- and long-term planning Implementation plans Annual work plans Budgeting *Quality assurance* - Implement risk management strategy *Networking* – Collective action on crop specific genetic resources in the CGIAR Developing genebank standards and procedures Establish and implement global crop conservation strategies Attend meetings and workshops organized through global crop strategies Attend genetic resources meetings	

ANNEX 5

Tables of Centre x Collection cost for 2009 (adjusted where needed) as derived from the Decision Support Tool

1. Africa Rice

1.1 Rice

	Africa Rice- Rice (2009 adjusted)						
Operations	**No. samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	2,608	18,869	7.24	296	One-off	0	7.24
Characterisation	3,451	56,153	16.27	11,563	One-off	0.00	16.27
Safety duplication	4,536	17,603	3.88	6,434	50	0.08	3.88
Preparing materials for long term storage at IITA	6,000	9,200	1.53	4,737	One-off	0.00	1.53
Long term storage at IITA	6,000		1.00	0	1	1.00	
Medium term storage	20,000	35,412	1.77	14,674	1	1.77	0.00
Germination testing	15,000	13,248	0.88	8,949	5	0.18	0.88
Regeneration	1,954	34,335	18.70	437	20	0.94	18.70
Seed processing	12,000	13,230	1.10	14,581	20	0.06	1.10
Seed health testing	1,050	22,002	20.95	5,038	20	1.05	20.95
Distribution	12,070	30,516	2.53	4,585	2	1.26	0.00
Information management	20,000	28,780	1.44	33,358	1	1.44	1.44
General management	20,000	45,831	2.29	15,144	1	2.29	2.29
Total	**20,000**	**325,178**	**79.59**	**119,794**		**10.06**	**74.29**

Footnotes

- Long-term storage is provided by IITA for about 6,000 accessions (not charged to AfricaRice at present. but allowed for in the model at current LTS costs/accession at IITA of $1.0 per accession per year (not including capital costs) plus transport costs Cotonou–Ibadan).
- Regeneration costs include the cycling of wild species for 2 years in the screen house at $33.19/accession

- Costing for health testing is taken from 2010 data. The procedure has recently been initiated and is likely to become less expensive with refinement
- No actual costs were provided for operations concerning the 462 accessions of wild rice. Wild rice is, therefore, costed as for cultivated rice.
- As for other Centres, per accession costs are based on 2009 data, but IRS staffing has been calculated using 2010 level (75% of an IRS) as the IRS position was vacant for much of 2009.
- 80% of distribution is within Africa, of which about 20% is within AfricaRice itself.
- One-off cost for optimization of the collection is for the regeneration of 8,000 accessions per year over the next 3-4 years to get everything into long-term storage (see Table 4.1).

2. Bioversity

2.1 Banana and Plantain

	Bioversity-Bananas (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	25	320	12.81	15	One-off	0.00	12.81
Characterisation	25	13,538	541.53	0	One-off	0.00	0.00
Field verification	80	25,548	319.35	0	10	31.94	0.00
Molecular characterisation	25	3,482	139.28	0	One-off	0.00	139.28
Safety duplication shipment	25	350	14.00	0	One-off	0.00	14.00
Safety duplication at IRD	562	3,000	5.34	1,905	2.3	2.32	0.00
Maintenance of the cryopreserved collection	800	14,655	18.32	3,442	1.6	11.45	0.00
Maintenance of in vitro collection	1,298	183,045	141.02	18,187	1	141.02	0.00
Stock maintenance in short term storage	50	8,815	176.30	4,272	26	6.78	0.00
Introduction into cryopreservation	35	54,495	1,557.00	9,250	One-off	0.00	1,557.00
Introduction into in vitro collection	25	13,090	523.61	4,427	One-off	0.00	523.61

Operations	Bioversity-Bananas (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualised costs	One-off costs
Leaf sample banking	80	12,421	155.26	5,389	16.2	9.58	0.00
Rejuvenation in greenhouses	80	64,587	807.34	2,501	10	80.73	0.00
Virus-indexing	25	0	458.00	0	One-off	0.00	458.00
Pre-indexing	100	0	211.00	0	One-off	0.00	211.00
Virus therapy	10	0	690.00	0	< One-off	0.00	276.00
In vitro multiplication & distribution	800	223,124	278.90	8,843	2	139.45	0.00
Information management	1,298	106,519	82.06	2,455	1	82.06	0.00
General management	1,298	191,022	147.17	2,770	1	147.17	0.00
Total	**1,298**	**918,012**	**6,278**	**63,456**		**652.50**	**3,191.70**

Footnotes

- The costs of molecular characterisation (ploidy and SSRs) are included as a routine means to verify the identity of accessions before they are processed for introduction into the collection.
- Field verification involves the shipping of accessions for planting and characterisation in the national programmes that house the original material.
- Costs of safety duplication are for the shipment of cryopreserved material to IRD, France. The data were provided in an email (27/10/10) from Nicolas Roux (100 accessions shipped every 4 years at the total cost of $1,400). There is a charge for housing the material at IRD and this is included as a recurrent cost under a separate operation.
- A short-term stock of popularly requested material is maintained to allow a higher rate of subculture.
- New accessions are first pre-indexed, those that are found to be negative are then fully virus-indexed. Approx. 40% of the accessions requires cleaning. Pre-indexing, indexing and cleaning are costed separately according to costs provided by Nicolas Roux in an email (27/10/10).
- The information management costs include the cost of operating the Musa Germplasm Information System (MGIS) http://www.crop-diversity.org/banana, which involves the management of data from national partners. This networking modus operandi partly accounts for why these costs, as well as general management, are considerably higher than for other Centres. As such, information and general management are only included as annual costs. They are not included in the costs of acquisition.
- The costs of 10% time of the cryopreservation expert are included in General Management, together with the costs of other technical and administration staff in Leuven and Montpellier offices.

- One-off cost for optimization of the collection is for cryopreserving the remaining 350 accessions in the existing collection together with 114 anticipated accessions are included as a one-off cost.
- The costs of introducing accessions from the Regeneration Project are already covered by the project and have not been included in table 4.2.

3. CIAT

3.1 Bean

Operations	CIAT-Beans (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	220	9,230	41.95	0	One-off	0.00	41.95
Characterisation	3,000	137,814	45.94	19,060	One-off	0.00	45.94
Safety duplication	4,047	26,872	6.64	2,634	30	0.22	6.64
Long-term storage	19,712	55,010	1.53	10,657	1	1.53	0.00
Medium-term storage	35,903	49,368	1.38	11,635	1	1.38	0.00
Germination testing	5,928	33,016	5.57	27,050	10	0.56	5.57
Regeneration	3,041	121,997	40.12	18,679	20	2.01	40.12
Seed processing	2,182	118,070	54.11	17,602	20	2.71	54.11
Seed health testing	2,802	139,329	49.72	48,616	20	2.49	49.72
Distribution	3,700	39,264	10.61	2,996	7	1.52	0.00
Information management	35,980	162,027	4.50	3,241	1	4.50	4.50
General management	35,980	92,577	2.57	15,351	1	2.57	2.57
Total	**35,903**	**984,574**	**264.65**	**177,521**		**19.48**	**251.13**

Footnotes

- Only 50% of the collection is physically held in long-term storage while seed increase continues. The long-term storage costs have been calculated based on the total number of accessions in the collection. The total costs for long-term storage are not expected to differ significantly with a change in accession number.
- Wild relatives are costed using the same per accession costs as cultivated accessions.
- One-off cost for optimization of the collection is for increasing seed for long-term storage is included as a one-off cost. The costs of characterisation were not included.

- CIAT undertakes molecular characterization of the bean collection, primarily for taxonomic reasons (at sub-species level for cultivated forms) at a cost of $12.43 per accession. For reasons of comparability across Centres, this cost has not been included.

3.2 Cassava

	CIAT-Cassava (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	125	2,661	21.29	0	One-off	0.00	21.29
Characterisation	1,500	4,405	2.94	0	-	0.00	0.00
Identification of duplicates & integrity	233	36,180	155.28	11,795	One-off	0.00	155.28
Safety duplication	1,380	45,342	32.86	13,187	1.67	19.67	32.86
Cryopreservation	640	39,631	61.92	2,092	10	6.19	61.92
In vitro conservation	7,539	183,464	27.83	23,284	1	27.83	27.83
Health testing & thermatherapy	553	49,126	88.84	25,663	One-off	0.00	88.84
Distribution	421	32,451	77.08	3,822	7	11.01	0.00
Information management	6,592	22,462	3.41	9,094	1	3.41	3.41
General management	6,592	24,775	3.76	13,614	1	3.76	3.76
Total	**6,592**	**440,499**	**475.20**	**102,552**		**71.88**	**395.18**

Footnotes

- Molecular and biochemical characterisation is recorded as a one-off operation only. However, only 15% of the cassava collection is characterised using diagnostic isozyme markers. Further characterisation may be considered as a one-off optimization cost.
- Safety duplication (at CIP) is a recurring cost because it involves *in vitro* cultures that require annual subculture. Only a proportion (approx 1/3rd) of the collection is duplicated in this way, although ideally it should be 100% of the collection that is safety duplicated.
- The per accession costs of *in vitro* conservation are based on the total accessions in the collection rather than the number of subcultures.
- 20% of the collection is held as ‘bonsai’ plants in the greenhouse. The costs of this are absorbed in the cost of characterisation and health testing, as are the costs of the herbarium
- Health testing includes the costs of some disease cleaning.

- There are several potential areas for optimizing the collection structure, in particular for improving safety duplication. These include: cryopreserving the collection, producing botanical seed or increasing the bonsai collection or any combination of these. The cost of introducing 1000 accessions into cryopreservation is included in Table 4.1 as per an email from Daniel Debouck (28/10/10).

3.3 Tropical Forages

	CIAT-Tropical forages (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	0	304	41.95	0	One-off	0.00	41.95
Characterisation	1,200	81,229	67.69	10,191	One-off	0.00	67.69
Safety duplication	3,388	26,383	7.79	5,905	25	0.31	7.79
Long term storage	23,140	44,175	1.91	10,497	1	1.91	0.00
Medium term storage	23,140	19,376	0.84	10,914	1	0.84	0.00
Germination testing	1,983	21,436	10.81	9,300	10	1.08	10.81
Regeneration	1,746	266,844	152.83	14,735	20	7.64	152.83
Seed processing	2,284	126,168	55.24	38,049	20	2.76	55.24
Seed health testing	2,225	87,591	39.37	31,692	20	1.97	39.37
Distribution	497	25,986	52.29	5,543	20	2.61	0.00
Information management	23,140	115,156	4.98	6,374	1	4.98	4.98
General management	23,140	62,954	2.72	14,569	1	2.72	2.72
Total	**23,140**	**877,602**	**438.41**	**157,770**		**26.82**	**383.38**

Footnotes

- No new acquisition is expected at least over the next few years because very few tropical forage genera are included in the multilateral system of access and benefit sharing under the International Treaty on PGRFA.
- Only 40% of the entire collection is physically held in long-term storage while seed increase continues. The long-term storage costs have been calculated based on the total number of accessions in the collection. The total costs are not expected to differ significantly.
- The costs of the field genebank are included in the costs of operations for regeneration and characterisation.
- One-off cost for optimization of the collection (Table 4.1) is for bringing 9,250 accessions into long-term storage.

4. CIMMYT

4.1 Maize

Operations	CIMMYT-Maize (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	653	12,175	18.64	503	One-off	0	18.64
Characterisation	643	66,729	10.00	1,856	One-off	0	10.00
Safety duplication	2,543	21,681	8.53	419	50	0.17	8.53
Long-term storage	27,440	5,561	0.20	5,143	1	0.20	0.00
Medium-term storage	27,440	4,911	0.18	5,143	1	0.18	0.00
Germination testing	1,440	8,659	6.01	3,131	10	0.60	6.01
Regeneration	643	99,598	250.00	1,730	30	8.33	250.00
Seed processing	643	28,722	44.67	1,978	30	1.49	44.67
Seed health testing	2,406	140,904	58.56	115	30	1.95	58.56
Distribution	8,028	28,650	3.57	899	7	0.51	0.00
Information management	27,440	26,419	0.96	6,003	1	0.96	0.96
General management	27,440	70,349	2.56	1,151	1	2.56	2.56
Total	**27,440**	**514,357**	**403.89**	**28,072**		**16.96**	**399.94**

Footnotes

- An estimate for the recurring costs of regenerating 300 high-altitude maize accessions outside Mexico every 30 years is added to the total costs of maintaining the collection for 2010 and in 2015 the estimate is added for regenerating 1000 high-altitude maize accessions.
- Significant costs are incurred due to the need to screen for presence of transgenes (GMO)
- CIMMYT is seeking ISO accreditation. The costs have not been included in the study but are in order of $100,000 for the process of accreditation (certification) and approx $20,000 per year to maintain it.
- Capital costs are likely to be underestimated because some equipment is not accounted for.

4.2 <u>Wheat</u>

	CIMMYT-Wheat, barley, triticale (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	2,000	14,017	7.01	869	One-off	0	7.01
Characterisation	2,400	0	3.50	658	One-off	0	3.50
Safety duplication	15,000	18,355	1.22	879	50	0.02	1.22
Long-term storage	127,689	10,716	0.08	15,851	1	0.08	0.00
Medium-term storage	127,689	10,101	0.08	15,851	1	0.08	0.00
Germination testing	3,000	6,769	2.26	3,765	10	0.23	2.26
Regeneration	12,000	73,968	6.16	1,760	30	0.21	6.16
Seed processing	12,000	28,982	2.42	3,457	30	0.08	2.42
Seed health testing	18,000	42,574	2.37	1,027	30	0.08	2.37
Distribution	5,000	24,406	4.88	540	20	0.24	0.00
Information management	127,689	132,827	1.04	30,878	1	1.04	1.04
General management	127,689	155,535	1.22	3,819	1	1.22	1.22
Total	**127,689**	**518,251**	**32.24**	**79,355**		**3.28**	**27.19**

<u>Footnotes</u>

- The collection includes approximately 440 accessions of rye (mainly *Secale cereale*) and 16,000 accessions of triticale (*Triticosecale*)
- Costs of characterisation were estimated and are not based on actual costs.
- Capital costs are likely to be underestimated because some equipment is not accounted for.

5. CIP

5.1 Andean Roots and Tubers

	CIP-Andean Roots & Tubers (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One off costs**
Acquisition	16	5,792	361.99	603	One-off	0	361.99
Characterisation	679	56,619	83.39	3,461	One-off	0	83.39
Safety duplication	1,061	22,996	21.67	1,770	1.7	12.75	21.67
Long term storage of seed	101	2,170	21.49	149	11	1.95	0.00
Field collection	768	49,565	64.54	2,900	1.7	37.96	0.00
In vitro conservation	1,011	34,088	33.72	2,690	1.3	25.94	0.00
Re-introduction into in vitro	50	8,612	172.23	683	20	8.61	0.00
Germination testing	25	1,202	48.07	5	90	0.53	0.00
Regeneration	25	6,452	258.09	32	90	2.87	0.00
Seed processing	25	2,289	91.57	184	90	1.02	0.00
Seed health testing	0	0	0.00	0	0	0.00	0.00
Distribution	79	9,082	114.96	396	20	5.75	0.00
Herbarium & verification	541	9,291	17.17	564	3.4	5.05	0.00
DNA genebank	400	2,153	5.38	897	4.5	1.20	0.00
Information management	1,174	36,647	31.22	1,784	1	31.22	31.22
General management	1,174	13,680	11.65	170	1	11.65	11.65
Total	**1,174**	**260,637**	**1,337**	**16,289**		**146.50**	**509.92**

Footnotes

- Acquisition costs include *in vitro* introduction. A total of 1792 accessions are expected to be introduced from various projects and collecting missions but the same 1% acquisition rate has been applied to be comparable with all Centres.
- Characterisation costs include field preparation and molecular characterisation.
- The procedure for health testing and cleaning of accessions is still to be put into place and is not included in the costs here.
- Distribution costs include the costs of multiplying *in vitro* materials.
- Evaluation was costed but is not included here.

- Information costs include the cost of bar-coding all accessions

5.2 Potato

6

	CIP-Potato (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	135	63,962	473.79	5,088	One-off	0	473.79
Characterisation & verification (DNA markers and nutritional markers)	1,000	111,754	111.75	5,097	One-off	0	111.75
Safety duplication - seed and in vitro	2,279	94,674	41.54	8,947	2	20.77	0.00
Long term storage of seed	14,379	96,051	6.68	21,190	0.5	13.36	0.00
Field collection	4,049	232,161	57.34	15,287	1.8	31.85	0.00
Cryopreservation (introduction, maintenance and monitoring)	150	89,062	593.75	33,183	One-off & annual	10.00	593.75
In vitro conservation	4,568	137,721	30.15	13,506	1.6	18.84	0.00
Re-introduction into in vitro	150	35,033	233.55	3,280	10	23.36	0.00
Germination testing	1,100	24,691	22.45	240	10	2.24	0.00
Regeneration of seed collection	600	43,861	73.10	778	20	3.66	0.00
Seed processing & health testing	600	35,117	58.53	4,404	20	2.93	0.00
Distribution	863	91,314	105.81	4,329	7	15.12	0.00
Herbarium & verification	7,203	64,902	9.01	7,514	1	9.01	0.00
DNA genebank	1,000	5,554	5.55	2,508	7.2	0.77	0
Information management	14,379	152,773	10.62	21,850	1	10.62	10.62
General management	14,379	128,793	8.96	2,082	1	8.96	8.96
Total	**7,213**	**1,508,466**	**1,983**	**159,168**		**171.49**	**1198.88**

7

Footnotes

- Acquisition costs include post-entry quarantine and introduction into *in vitro*. Seeds may also be introduced at a lesser cost but the recurring cost of introduction, here, is based on accessions being provided as *in vitro* cultures (the most common method of introduction).

- Characterisation costs include field preparation to grow out plants for morphological characterisation, as well as molecular characterisation for the identification (and elimination) of duplicates.
- Safety duplication includes the cost of both seed and *in vitro* duplication.
- The long-term seed storage contains almost double the number of accessions than the number considered to be unique in the entire collection. This is because duplicates have been processed into seed.
- Potato may be cryopreserved using routine methods, at least for roughly 50% of genotypes. The cost of cryopreservation was not divided into maintenance and introduction costs as with other Centres. An estimated cost was, therefore, used for maintenance.
- Field collection costs include *c*ollections in two sites and tuber storage costs. These costs will be rationalized in the years to come.
- Seed processing costs include seed health testing and cleaning.
- A cost for the recurring re-introduction of materials from the field into *in vitro* to refresh ageing cultures is included.
- Health testing is for the testing and cleaning of a backlog of around 1396 accessions in vitro (this might otherwise.
- Distribution costs include the costs of multiplying *in vitro* materials.
- Accessions may be introduced as seed or as vegetative materials. The costs of the latter are greater but are most frequent and are thus used to estimate recurring acquisition costs.
- Information costs include the cost of bar-coding all accessions
- Evaluation was costed but is not included here.
- One-off costs for optimisation of the collection is for the cryopreservation of 750 accessions and health testing of 1,415 accessions.

7.1 Sweetpotato

Operations	CIP-Sweet Potato (2009 adjusted)						
	No.samples	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	263	85,591	325.44	9,912	One-off	0	325.44
Characterisation & verification (DNA markers and nutritional markers)	1,350	111,611	82.68	6,881	One-off	0	82.68
Safety duplication - seed & in vitro	6,352	115,404	18.17	10,599	1.3	13.98	0.00
Long term storage of seed	4,971	37,610	7.57	7,326	1.6	4.73	0.00
Field collection in screenhouses	3,463	113,523	32.78	13,075	2.3	14.25	0.00
Cryopreservation	40	61,567	1,539.18	8,849	One-off & annual	10.00	1539.18
In vitro conservation	5,352	161,589	30.19	13,790	1.5	20.13	0.00
Re-introduction into in vitro	150	54,493	363.29	4,521	10	36.33	0.00
Germination testing	600	19,972	33.29	131	10	3.33	0.00
Seed regeneration in greenhouse	700	51,510	73.59	908	20	3.68	0.00
Seed processing & health testing	600	37,759	62.93	4,404	20	3.15	0.00
Distribution (including in vitro multiplication)	1,728	183,248	106.05	8,668	7	15.15	0.00
Herbarium & verification	1,000	17,353	17.35	1,043	8.1	2.14	0.00
DNA genebank	1,850	11,699	6.32	4,295	4.4	1.44	0.00
Information management	8,108	117,963	14.55	12,321	1	14.55	14.55
General management	8,108	72,155	8.90	1,174	1	8.90	8.90
Total	**8,108**	**1,253,048**	**2,722**	**107,896**		**151.75**	**1970.74**

Footnotes

- Acquisition costs include post-entry quarantine and introduction into *in vitro*.

- Characterisation costs include field preparation for morphological characterisation, as well as molecular characterisation.
- Safety duplication includes the cost of both seed and *in vitro* duplication.
- The cost of cryopreservation was not divided into maintenance and introduction costs as with other Centres. An estimated cost was, therefore, used for maintenance.
- Seed processing costs include seed health testing and cleaning.
- A cost for the recurring re-introduction of materials from the field into *in vitro* to refresh ageing cultures is included.
- Distribution costs include the costs of multiplying *in vitro* materials.
- Information costs include the cost of bar-coding all accessions
- Evaluation was costed but is not included here.
- Acquisitions are accepted as *in vitro* materials only. Seed processing is therefore not included in one-off costs of acquisition.
- One-off costs for optimisation of the collection is for the cryopreservation of 750 accessions and health testing of 2,896 accessions.

6. ICARDA

- The Rhizobium collection of 1,400 accessions has not been included in the costings. Total annual maintenance cost is estimated to be approx $1,500
- ICARDA states an urgent need for additional senior staff strength, especially to handle the forage and rangeland species collection (which has a large number of species, with significant taxonomic issues, diversity of reproductive biology etc.. See also Section 4.

6.1 Barley

	ICARDA-Barley (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off**
Acquisition	103	937	9.09	113	One-off	0.00	9.09
Characterisation	1,737	25,433	14.64	5,959	One-off	0.00	14.64
Safety duplication	13,200	4,343	0.33	1,643	50	0.01	0.33
Long-term storage	26,345	20,137	0.76	7,165	1	0.76	0.00
Medium-term storage	26,856	21,866	0.81	13,028	1	0.81	0.00
Germination testing	2,300	3,954	1.72	1,025	10	0.17	1.72
Regeneration	16	473	29.57	81	20	1.48	29.57
Seed processing	21,599	6,927	0.32	1,538	10	0.03	0.32
Seed health testing	3,191	12,476	3.91	5,959	10	0.39	3.91
Distribution	19,846	20,471	1.03	3,757	2	0.52	0.00
Information management	26,856	28,054	1.04	2,487	1	1.04	1.04
General management	26,856	11,532	0.43	540	1	0.43	0.43
Total	**26,856**	**156,603**	**63.66**	**43,295**		**5.65**	**61.05**

6.2 Chickpea

Operations	ICARDA- Chickpea (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualised costs	One-off
Acquisition	243	2,871	11.81	266	One-off	0.00	11.81
Characterisation	1,774	31,418	17.71	6,086	One-off	0.00	17.71
Safety duplication	4,897	1,797	0.37	610	50	0.01	0.37
Long-term storage	12,154	10,860	0.89	3,305	1	0.89	0.00
Medium-term storage	13,462	12,298	0.91	6,530	1	0.91	0.00
Germination testing	1,153	1,982	1.72	514	10	0.17	1.72
Regeneration	1,837	53,928	29.36	9,349	20	1.47	29.36
Seed processing	11,628	8,541	0.73	828	10	0.07	0.73
Seed health testing	2,589	10,122	3.91	4,835	10	0.39	3.91
Distribution	8,017	9,698	1.21	1,518	2	0.60	0.00
Information management	13,462	14,834	1.10	1,247	1	1.10	1.10
General management	13,462	6,226	0.46	270	1	0.46	0.46
Total	**13,462**	**164,576**	**70.19**	**35,358**		**6.09**	**67.18**

6.3 Faba bean

	ICARDA-Faba bean (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off**
Acquisition	107	1,264	11.81	105	One-off	0.00	11.81
Characterisation	798	14,133	17.71	12,515	One-off	0.00	17.71
Safety duplication	4,277	1,570	0.37	2,083	50	0.01	0.37
Cryopreservation					-	-	
In vitro conservation					-	-	
Long-term storage	2,900	2,591	0.89	1,632	1	0.89	0.00
Medium-term storage	9,181	8,387	0.91	8,855	1	0.91	0.00
Germination testing	786	1,352	1.72	350	10	0.17	1.72
Regeneration	798	23,427	29.36	13,838	20	1.47	29.36
Seed processing	8,195	6,020	0.73	584	10	0.07	0.73
Seed health testing	1,336	5,223	3.91	2,495	10	0.39	3.91
Distribution	6,599	7,983	1.21	6,319	2	0.60	0.00
Information management	9,181	10,117	1.10	850	1	1.10	1.10
General management	9,181	4,246	0.46	184	1	0.46	0.46
Total	**9,181**	**86,312**	**70.19**	**49,811**		**6.09**	**67.17**

Footnotes

- *Vicia faba* has a high percentage of out-crossing and pollination control measures are needed to maintain accession integrity, resulting in relatively high regeneration costs.

6.4 Forage and Range Plants

Operations	ICARDA-Forage and Range Plants (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualized costs	One-off costs
Acquisition	34	1,738	51.13	36	One-off	0	51.13
Characterisation	1,461	12,544	8.59	16,958	One-off	0	8.59
Herbarium	10,954	25,242	2.30	6,605	2.2	1.05	
Safety duplication	11,573	3,935	0.34	2,844	50	0.01	0.34
Long-term storage	18,271	13,812	0.76	6,900	1	0.76	0.00
Medium-term storage	24,606	18,735	0.76	16,810	1	0.76	0.00
Germination testing	2,108	2,838	1.35	939	10	0.13	1.35
Regeneration	1,507	47,998	31.85	19,615	20	1.59	31.85
Seed processing	16,451	10,508	0.64	1,172	10	0.06	0.64
Seed health testing	1,268	5,513	4.35	2,368	10	0.43	4.35
Distribution	13,483	16,925	1.26	5,901	2	0.63	0.00
Information management	24,606	22,203	0.90	2,279	1	0.90	0.90
General management	24,606	9,556	0.39	494	1	0.39	0.39
Total	**24,606**	**191,548**	**104.60**	**82,921**		**6.72**	**99.53**

Footnotes

- No new acquisitions are expected
- The costs of the herbarium are included in the costs for tropical forages

6.5 Grasspea (*Lathyrus*)

	ICARDA-Grasspea (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualized costs**	**One-off costs**
Acquisition	100	1,777	17.77	98	One-off	0	17.77
Characterisation	0	0	0.00	0	One-off	0	0.00
Safety duplication	1,838	605	0.33	895	50	0.01	0.33
Cryopreservation					-	-	0.00
In vitro conservation					-	-	0.00
Long-term storage	2910	2224	0.76	1,638	1	0.76	0.00
Medium-term storage	3310	2695	0.81	3,192	1	0.81	0.00
Germination testing	284	487	1.72	126	10	0.17	1.72
Regeneration	0	0	31.83	0	20	1.59	31.83
Seed processing	0	0	1.40	0	10	0.14	1.40
Seed health testing	1,310	5,122	3.91	2,446	10	0.39	3.91
Distribution	3,181	3,907	1.23	3,046	2	0.61	0.00
Information management	3,310	3,653	1.10	307	1	1.10	1.10
General management	3,310	1,421	0.43	67	1	0.43	0.43
Total	**3,210**	**21,891**	**61.30**	**11,815**		**6.03**	**58.49**

6.6 Lentil

Operations	ICARDA-Lentil (2009 adjusted)						
	No.samples	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualized costs**	**One-off costs**
Acquisition	151	1,784	11.81	165	One-off	0	11.81
Characterisation	638	11,299	17.71	2,189	One-off	0	17.71
Safety duplication	5,494	2,016	0.37	684	50	0.01	0.37
Cryopreservation	0	0	0.00	0	-	-	0.00
In vitro conservation	0	0	0.00	0	-	-	0.00
Long-term storage	10,814	9,663	0.89	2,941	1	0.89	0.00
Medium-term storage	11,008	10,056	0.91	5,340	1	0.91	0.00
Germination testing	943	1,621	1.72	420	10	0.17	1.72
Regeneration	759	22,282	29.36	3,863	20	1.47	29.36
Seed processing	9,373	6,885	0.73	668	10	0.07	0.73
Seed health testing	2,118	8,281	3.91	3,955	10	0.39	3.91
Distribution	7,976	9,649	1.21	1,510	2	0.60	0.00
Information management	11,008	12,130	1.10	1,019	1	1.10	1.10
General management	11,008	5,091	0.46	221	1	0.46	0.46
Total	**11,008**	**100,756**	**70.19**	**22,975**		**6.09**	**67.18**

6.7 Pea

Operations	ICARDA-Pea (2009 adjusted)						
	No.samples	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualized costs**	**One-off costs**
Acquisition	8	142	17.77	9	One-off	0	17.77
Characterisation	1,481	27,188	18.36	5,081	One-off	0	18.36
Safety duplication	2,156	709	0.33	268	50	0.01	0.33
Cryopreservation					-	-	-
In vitro conservation					-	-	-
Long-term storage	4846	3,704	0.76	1,318	1	0.76	0.00
Medium-term storage	6075	4,946	0.81	2,947	1	0.81	0.00
Germination testing	520	895	1.72	232	10	0.17	1.72
Regeneration	890	28,326	31.83	4,529	20	1.59	31.83
Seed processing	5,832	8,190	1.40	415	10	0.14	1.40
Seed health testing	1,266	4,950	3.91	2,364	10	0.39	3.91
Distribution	3,461	4,251	1.23	655	2	0.61	0.00
Information management	6,075	6,705	1.10	563	1	1.10	1.10
General management	6,075	2,609	0.43	122	1	0.43	0.43
Total	**6,075**	**92,615**	**79.66**	**18,504**		**6.03**	**76.85**

6.8 Wheat

	ICARDA-Wheat (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off**
Acquisition	873	7,939	9.09	955	One-off	0.00	9.09
Characterisation	2,496	36,547	14.64	8,563	One-off	0.00	14.64
Safety duplication	19,913	6,552	0.33	2,479	50	0.01	0.33
Cryopreservation	0	0	0.00	0	-	-	0.00
In vitro conservation	0	0	0.00	0	-	-	0.00
Long-term storage	38,000	29,045	0.76	10,335	1	0.76	0.00
Medium-term storage	39,762	32,374	0.81	19,288	1	0.81	0.00
Germination testing	3,406	5,855	1.72	1,518	10	0.17	1.72
Regeneration	1,061	31,369	29.57	5,400	10	2.96	29.57
Seed processing	37,721	12,097	0.32	2,687	10	0.03	0.32
Seed health testing	8,040	31,434	3.91	15,014	10	0.39	3.91
Distribution	34,164	35,240	1.03	6,468	2	0.52	0.00
Information management	39,762	41,535	1.04	3,683	1	1.04	1.04
General management	39,762	17,418	0.44	824	1	0.44	0.44
Total	**39,762**	**287,406**	**63.67**	**77,213**		**7.14**	**61.06**

7 ICRISAT

7.1 Chickpea

	ICRISAT-Chickpea (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	391	13,375	34.21	38	One-off	0	34.21
Characterisation	591	17,706	29.96	693	One-off	0	29.96
Safety duplication	4,000	19,916	4.98	355	50	0.10	4.98
Long-term storage	16,977	10,348	0.61	1,146	1	0.61	0.00
Medium-term storage	20,267	11,058	0.55	7,533	1	0.55	0.00
Germination testing	3,500	9,647	2.76	2,890	5	0.55	2.76
Regeneration	4,300	90,616	21.07	4,217	15	1.40	21.07
Seed processing	7,150	25,318	3.54	4,856	15	0.24	3.54
Seed health testing	560	3,254	5.81	0	15	0.39	5.81
Distribution	10,500	75,430	7.18	115	2	3.59	0.00
Information management	20,267	28,010	1.38	2,850	1	1.38	1.38
General management	20,267	39,225	1.94	6,124	1	1.94	1.94
Total	**20,267**	**343,904**	**113.99**	**30,815**		**10.74**	**105.65**

7.2 Groundnut

Operations	ICRISAT-Groundnut (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	260	8,894	34.21	25	One-off	0	34.21
Characterisation	510	18,064	35.42	778	One-off	0	35.42
Safety duplication	3,000	14,937	4.98	267	50	0.10	4.98
Long-term storage	13,984	8,523	0.61	944	1	0.61	0.00
Medium-term storage	15,445	8,427	0.55	5,740	1	0.55	0.00
Germination testing	4,500	12,403	2.76	3,715	5	0.55	2.76
Regeneration	5,200	111,019	21.35	5,100	10	2.13	21.35
Seed processing	5,000	23,696	4.74	3,396	10	0.47	4.74
Seed health testing	550	7,811	14.20	0	10	1.42	14.20
Distribution	12,500	89,798	7.18	136	2	3.59	0.00
Information management	15,445	21,346	1.38	2,172	1	1.38	1.38
General management	15,445	29,892	1.94	4,667	1	1.94	1.94
Total	**15,445**	**354,811**	**129.31**	**26,939**		**12.74**	**121**

7.3 Pearl Millet

Operations	ICRISAT-Pearl Millet (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	633	22,024	34.79	62	One-off	0	34.79
Characterisation	1,283	25,632	19.98	1,637	One-off	0	19.98
Safety duplication	4,000	17,911	4.48	355	50	0.09	4.48
Long-term storage	20,780	12,529	0.60	1,402	1	0.60	0.00
Medium-term storage	22,211	12,111	0.55	8,255	1	0.55	0.00
Germination testing	1,800	4,961	2.76	1,486	10	0.28	2.76
Regeneration	1,500	128,278	85.52	1,471	15	5.70	85.52
Seed processing	6,250	21,679	3.47	4,244	15	0.23	3.47
Seed health testing	760	2,765	3.64	0	15	0.24	3.64
Distribution	5,800	52,264	9.01	63	7	1.29	0.00
Information management	22,211	35,009	1.58	3,123	1	1.58	1.58
General management	22,211	42,964	1.93	6,711	1	1.93	1.93
Total	**22,211**	**378,127**	**168.30**	**28,811**		**12.49**	**158.14**

7.4 Pigeonpea

Operations	ICRISAT-Pigeon pea (2009 adjusted)						
	No.samples	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	277	9,638	34.79	27	One-off	0.00	34.79
Characterisation	527	10,529	19.98	618	One-off	0.00	19.98
Safety duplication	3,000	13,433	4.48	267	50	0.09	4.48
Long-term storage	12,084	7,286	0.60	815	1	0.60	0.00
Medium-term storage	13,632	7,433	0.55	5,067	1	0.55	0.00
Germination testing	1,500	4,134	2.76	1,238	10	0.28	2.76
Regeneration	800	72,831	91.04	785	15	6.07	91.04
Seed processing	4,100	14,795	3.61	2,784	15	0.24	3.61
Seed health testing	450	1,637	3.64	0	15	0.24	3.64
Distribution	4,700	42,352	9.01	51	7	1.29	0.00
Information management	13,632	21,487	1.58	1,917	1	1.58	1.58
General management	13,632	26,369	1.93	4,119	1	1.93	1.93
Total	**13,632**	**231,923**	**173.96**	**17,688**		**12.86**	**163.80**

7.5 Small Millets

	ICRISAT-Small millets (2009 adjusted)						
Operations	**No.samples**	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	463	14,356	31.01	45	One-off	0.00	31.01
Characterisation	400	32,194	80.49	469	One-off	0.00	80.49
Safety duplication	1,000	12,433	12.43	89	50	0.25	12.43
Long-term storage	7,752	5,601	0.72	523	1	0.72	0.00
Medium-term storage	10,235	6,333	0.62	3,804	1	0.62	0.00
Germination testing	500	1,378	2.76	413	10	0.28	2.76
Regeneration	900	52,031	57.81	883	15	3.85	57.81
Seed processing	2,000	13,938	6.97	1,358	15	0.46	6.97
Seed health testing	900	3,274	3.64	0	15	0.24	3.64
Distribution	4,500	44,568	9.90	49	2	4.95	0.00
Information management	10,235	21,042	2.06	1,439	1	2.06	2.06
General management	10,235	23,677	2.31	3,093	1	2.31	2.31
Total	**10,235**	**230,826**	**210.72**	**12,164**		**15.75**	**199.47**

7.6 Sorghum

Operations	ICRISAT-Sorghum (2009 adjusted)						
	No.samples	Total cost	Total average cost	Capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	1,611	44,577	27.67	157	One-off	0	27.67
Characterisation	2,111	31,132	14.75	2,694	One-off	0	14.75
Safety duplication	8,000	29,553	3.69	711	50	0.07	3.69
Long-term storage	35,539	19,389	0.55	2,398	1	0.55	0.55
Medium-term storage	37,949	18,732	0.49	14,104	1	0.49	0.49
Germination testing	3,500	9,647	2.76	2,890	10	0.28	2.76
Regeneration	2,500	114,731	45.89	2,452	15	3.06	45.89
Seed processing	9,150	25,893	2.83	6,214	15	0.19	2.83
Seed health testing	450	6,918	15.37	0	15	1.02	15.37
Distribution	11,500	90,493	7.87	125	7	1.12	7.87
Information management	37,949	56,623	1.49	5,336	1	1.49	1.49
General management	37,949	72,984	1.92	11,467	1	1.92	1.92
Total	**37,949**	**520,671**	**125**	**48,547**		**10.20**	**125.29**

Footnotes for All ICRISAT Tables

- Accessions are held in India and in up to three African regional genebanks (Niamey, Nairobi and/or Bulawayo). Operation costs for the African collections were estimated and added as total costs to the total annualised costs of the main genebank in India for each crop.
- A quarantine cost of $14 per accession is added to material distributed from India outside of the country.
- Some unique materials held in the African genebanks are expected to be shipped for long-term conservation to the main genebank in India. This has not been costed or included here or in Table 4.1.

8. IITA

8.1 Banana and Plantain

Operations	IITA-Banana (2009 adjusted)						
	No. samples	Total cost	Total average cost	Total capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	0	0	0.00	0	0	0	0.00
Characterisation	0	0	0.00	0	0	0	0.00
Safety duplication	0	0	0.00	0	One-off	0	0.00
In-vitro conservation	150	4,541	30.27	1,113	1.9	15.93	0.00
In vitro introduction	150	26,152	174.35	7,750	7.5	23.25	0.00
Field bank	290	5,187	17.89	111	1	17.89	0.00
Seed health testing	0	0	60.00	0	10	6	0.00
Distribution	6	261	43.49	33	20	2.17	0.00
Information management	290	892	3.08	127	1	0.50	0.00
General management	290	204	0.70	183	1	0.50	0.00
Total	**290**	**37,237**	**329.77**	**9,317**		**66.24**	**0.00**

Footnotes

- No further acquisitions are expected in this collection with the exception of the possible rescue of accessions from the Onne field collection.
- There is no safety duplication. The *in vitro* collection duplicates the field collection and much of the unique material is held in the Bioversity genebank. There is believed to be a small number more accessions that should still be sent to Bioversity. The cost of making this transfer of materials has not been included in costings here.
- Health testing of banana is not fully established at IITA. An estimated cost is proposed that lies somewhere between the costs of testing cassava and those of yam. Only African pests and diseases will be tested.

8.2 Cassava

Operations	IITA-Cassava (2009 adjusted)						
	No.samples	Total cost	Total average cost	Total capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	67	2,722	40.63	705	One-off	0.00	40.63
Characterization	2,783	17,121	6.15	2,867	One-off	0.00	6.15
Safety duplication	1,050	9,665	9.20	4,328	2.7	3.41	0.00
Cryo-preservation	-	-	-	-	-	-	-
In-vitro conservation	2,637	82,131	31.15	19,733	1	31.15	0.00
In vitro introduction	289	50,962	176.34	15,062	One-off & 15	11.76	176.34
Field bank	2,783	47,882	17.21	1,065	1	17.21	0.00
Regeneration	-	-	-	-	-	-	-
Seed health testing	872	36,221	41.54	13,750	One-off	0.00	41.54
Distribution	54	2,923	54.13	301	20	2.71	0.00
Information management	2,783	8,559	3.08	1,223	1	3.08	3.08
General management	2,783	1,961	0.70	3,298	1	0.70	0.70
Total	**2,783**	**260,147**	**380.13**	**62,331**		**70.00**	**268.44**

Footnotes

- A recurring cost has been added for *in vitro* introduction to account for the refreshing of *in vitro* materials from the field.
- There is a plan to start cryopreserving and characterising the collection using SSRs but this is not costed.

8.3 Cowpea

Operations	IITA-Cowpea (2009 adjusted)						
	No.samples	Total cost	Total average cost	Total capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	0	0	10.00	0	One-off	0	10.00
Characterization	0	0	22.77	0	One-off	0	22.77
Safety duplication	13,105	47,840	3.65	3,990	40	0.09	3.65
Long term storage	16,517	21,068	1.28	59,080	1	1.28	0.00
Medium term storage	16,517	19,475	1.18	79,332	1	1.18	0.00
Germination testing	1,977	10,215	5.17	8,739	15	0.34	5.17
Regeneration	1,753	46,266	26.39	3,380	15	1.76	26.39
Seed processing	3,253	42,972	13.21	34,450	15	0.88	13.21
Seed health testing	1,477	56,821	38.47	18,754	15	2.56	38.47
Distribution	341	12,241	35.90	1,910	20	1.79	0.00
Information management	16,629	9,164	0.55	7,919	1	0.55	0.55
General management	16,629	11,730	0.71	6,024	1	0.71	0.71
Total	**16,629**	**277,794**	**159.27**	**223,578**		**11.15**	**120.92**

Footnotes

- There were no acquisitions in any seed crop collection at IITA in 2009. The costs for acquisition are estimated to be $10/accession.
- There are no actual costs for characterisation. The cost for this activity is taken from the costs of the operation for Africa yam bean.
- Wild *Vigna* (1,516 accessions) is more expensive to regenerate because it involves planting out in greenhouses and hand-pollination. However, as the operation was not taking place during the course of the study, it was not costed. Regeneration costs are, thus, marginally underestimated.
- Only 20% of the collection is health-tested. The costs of health testing and seed processing 80% of the collection are included as a one-off cost in Section 4 (presuming there is sufficient capacity to test and process 2,661 accessions/year). This does not include the cost of regeneration, characterisation and germination testing.

8.4 Maize

Operations	IITA-Maize (2009 adjusted)						
	No.samples	Total cost	Total average cost	Total capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	0	0	10.00	0	One-off	0	10.00
Characterisation	100	4,347	43.47	881	One-off	0.00	43.47
Safety duplication	119	434	3.65	36	40	0.09	3.65
Long term storage	878	1,120	1.28	3,141	1	1.28	0.00
Medium term storage	878	1,035	1.18	4,217	1	1.18	0.00
Germination testing	0	0	4.98	0	5	1.00	4.98
Regeneration	100	5,773	57.73	193	20	2.89	57.73
Seed processing	100	1,211	12.11	1,059	20	0.61	12.11
Seed health testing	450	17,312	38.47	5,714	20	1.92	38.47
Distribution	58	2,186	37.70	325	20	1.88	0.00
Information management	878	499	0.57	418	1	0.57	0.57
General management	878	619	0.71	318	1	0.71	0.71
Total	**878**	**34,537**	**211.83**	**16,301**		**12.12**	**171.68**

Footnotes

- There were no acquisitions in any seed crop collection at IITA in 2009. The costs for acquisition are estimated to be $10/accession.
- There are no actual costs for germination testing of maize. The cost for this activity is taken from the costs of the operation for cowpea.
- The expected acquisition rate is likely to be higher than 1% of the collection for a short period, since new West African accessions are being actively sought.
- One-off cost for optimization of the collection (Table 4.1) is for the characterisation and safety duplication of 300 accessions.

8.5 Miscellaneous Food Legumes

Operations	IITA-African yam bean, bambara groundnut, soybean & Misc legumes (2009 adjusted)						
	No.samples	Total cost	Total average cost	Total capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	0	0	10.00	0	One-off	0	10.00
Characterization	98	2,336	23.83	863	One-off	0	23.83
Safety duplication	3,519	12,846	3.65	1,071	40	0.09	3.65
Long term storage	3,746	4,778	1.10	13,399	1	1.10	0.00
Medium term storage	4,346	5,124	1.18	20,874	1	1.18	0.00
Germination testing	265	1,369	5.17	1,171	15	0.34	5.17
Regeneration	265	6,994	26.39	511	15	1.76	26.39
Seed processing	265	3,209	12.11	2,806	15	0.81	12.11
Seed health testing	0	0	10.74	0	15	0.72	10.74
Dissemination	562	18,157	32.31	3,148	7	4.62	0.00
Information management	4,346	1,995	0.46	2,070	1	0.46	0.46
General management	4,346	3,066	0.71	1,574	1	0.71	0.71
Total	**4,346**	**59,875**	**127.65**	**47,488**		**11.78**	**93.06**

Footnotes

- There were no acquisitions in any seed crop collection at IITA in 2009. The costs for acquisition are estimated to be $10/accession.
- The per accession long-term storage costs were determined using the total number of accessions in the entire collection.
- There are no actual costs for routine operations such as germination testing, regeneration, seed processing, seed health testing since these operations are presently not occurring. The costs for these activities are taken from the costs of operations for cowpea.

8.6 Yam

Operations	IITA-Yam (2009)						
	No.samples	**Total cost**	**Total average cost**	**Total capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	423	16,869	31.80	4,448	One-off	0	31.80
Characterization	0	5,834	5.09	0	One-off	0	5.09
Safety duplication	676	14,397	21.30	2,758	5	4.26	0.00
Cryo-preservation	0	0	0.00	0	0	0	0.00
In-vitro conservation	1,469	45,082	30.69	10,896	2.3	13.34	0.00
In vitro introduction	8	2,005	250.68	413	One-off & 15	16.71	250.68
Field bank	3,360	31,780	9.46	1,286	1	9.46	0.00
Seed health testing	213	9,521	44.70	3,348	One off & 5	8.94	44.70
Distribution	381	19,058	50.02	2,121	7	7.15	0.00
Information management	3,360	11,306	3.36	1,477	1	3.36	3.36
General management	3,360	2,368	0.70	2,115	1	0.70	0.70
Total	**3,360**	**158,220**	**447.81**	**28,862**		**63.93**	**336.34**

Footnotes

- There are no actual costs for characterisation. The cost of this activity was taken from cassava.
- The accessions from the field collection continue to be introduced into *in vitro*. This is a slow process as the protocol is not yet fully optimised. The cost of bringing accessions into *in vitro* is included as a recurring as well as an one-off cost.
- Seed health-testing is included as a recurring cost as well as an one-off cost to allow for the processing of 90% of the collection that still requires health testing.
- Total annualised costs are derived from the number of accessions in the field collection.
- Molecular characterisation, cryopreservation, in vitro conservation and seed health testing for yam all involve non-optimised protocols that demand research resources to refine. These costs are not included.

9. ILRI

9.1 Tropical Forages

Operations	ILRI-Forages & Fodder (2009 adjusted)						
	No.samples	**Total cost**	**Total average cost**	**Capital cost**	**Periodicity**	**Annualised costs**	**One-off costs**
Acquisition	0	0	0.00	0	One-off	0	0.00
Characterisation	516	22,576	43.75	9,234	One-off	0	43.75
Biochemical analysis	200	8,040	40.20	0	One-off	0	40.20
Safety duplication	650	27,569	42.41	162	100	0.42	42.41
Long-term storage	5,006	26,449	5.28	5,499	1	5.28	0.00
Medium-term storage	18,456	39,200	2.12	48,309	1	2.12	0.00
Field bank	1,417	35,400	24.98	6,783	15	1.67	24.98
Germination testing	1,512	56,790	37.56	23,313	10	3.76	37.56
Regeneration	1,501	153,309	102.14	11,660	20	5.11	102.14
Seed processing	1,300	32,611	25.09	26,819	20	1.25	25.09
Seed health testing	1,058	135,167	127.76	33,769	20	6.39	127.76
Distribution	1,760	41,995	23.86	5,190	7	3.41	0.00
Information management	23,462	42,453	1.81	11,359	1	1.81	1.81
General management	23,462	40,591	1.73	18,731	1	1.73	1.73
Total	**18,921**	**662,149**	**479**	**200,828**		**32.95**	**447.43**

Footnotes

- The costs were originally calculated for eight crop categories. These were summed and averaged to derive the final costing here.
- No further acquisition is expected because very few tropical forage genera are included in the multilateral system of access and benefit sharing under the International Treaty on PGRFA.
- As with all crop collections, the total annualised cost is based on the number of unique accessions in the collection rather than the cumulative total number of accessions held in different forms (i.e. field plus long-term storage, etc).
- The actual costs of characterisation in 2009 included a postdoc who trained staff during the year. This cost ($73,500) has been removed from this costing.

- The per accession costs of biochemical/nutritional analyses are calculated from an email from Alejandra Jorge (25/10/10) and are not based on actual costs. Nutritional characterisation is important for the direct use of the collection.
- Long-term storage costs are based on the number of accessions in storage rather than the total size of the collection (unlike CIAT). This is because the accessions are conserved in freezers rather than a storage room.
- One-off cost for optimization of the collection given in Table 4.1 is for processing 4000 accessions from medium-term storage and the field genebank into long-term storage. As there is a maximum capacity of 900 accessions that can be processed in a year, the costs for processing only 4,000 accessions are included here.
- Capital costs tend to be high as there is little opportunity to share facilities with other units.

10. IRRI

10.1 Rice

Operations	IRRI- Cultivated rice (2009 adjusted)						
	No.samples	Total cost	Total average cost	Total capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	661	16,171	24.46	413	One-off	0.00	24.46
Characterisation	2,216	55,580	25.08	5,962	One-off	0.00	25.08
Safety duplication	1,300	13,330	10.25	1,048	50	0.21	10.25
Long term storage	106,319	31,704	0.30	34,235	1	0.30	0.00
Medium term storage	106,319	36,384	0.34	29,765	1	0.34	0.00
Germination testing	39,696	39,587	1.00	43,603	5	0.20	1.00
Regeneration	3,467	93,235	26.89	20,237	20	1.34	26.89
Seed processing	4,357	88,560	20.33	32,269	20	1.02	20.33
Seed health testing	3,840	18,898	4.92	3,502	20	0.25	4.92
Distribution	18,537	52,066	2.81	2,786	7	0.40	0.00
Information management	106,319	156,360	1.47	14,181	1	1.47	1.47
General management	106,319	195,283	1.84	17,484	1	1.84	1.84
Total	**106,319**	**797,157**	**120**	**205,485**		**7.36**	**116.24**

Operations	IRRI-Wild Rice (2009 adjusted)						
	No.samples	Total cost	Total average cost	Total capital cost	Periodicity	Annualised costs	One-off costs
Acquisition	0	152	15.19	6	One-off	0.00	15.19
Characterisation	407	46,594	114.48	64,788	One-off	0.00	114.48
Safety duplication	0	103	10.25	8	50	0.21	10.25
Long term storage	4,498	1,341	0.30	1,437	1	0.30	0.00
Medium term storage	4,498	1,539	0.34	1,259	1	0.34	0.00
Germination testing	100	245	2.45	110	One-off	0.00	2.45
Regeneration	500	134,210	268.42	66,120	20	13.42	268.42
Seed processing	500	12,347	24.69	3,557	20	1.23	24.69
Seed health testing	20	98	4.92	18	20	0.25	4.92
Distribution	2,426	7,615	3.14	365	2	1.57	0.00
Information management	4,498	7,343	1.63	600	1	1.63	1.63
General management	4,498	10,446	2.32	740	1	2.32	2.32
Total	**4,498**	**222,033**	**448**	**139,008**		**21.27**	**444.37**

Footnotes for Appendix table

- Costs for maintaining wild rice are considerably higher than cultivated rice ($20.33 cf $7.52 per accession annualized cost). Operations are costed separately and total annualised costs are then divided by the total number of accessions to derive an annualised per accession cost. At present, 4,500 accessions of 110,000 accessions are wild species. If this proportion were to change the costs of running the collection would be significantly affected.
- Preferred rates of regeneration and seed processing were every 11 years but were increased to 20 years to be comparable with other centres.
- Wild and cultivated rice have been combined in the Summary table for IRRI-Rice in Section 3.